J SERIES, VOL. II, No. 4 NOVEMBER, 1942



# PALESTINE JOURNAL OF BOTANY

*Jerusalem Series*

EDITED BY

THE STAFF OF THE DEPARTMENT OF BOTANY OF THE HEBREW UNIVERSITY

CONTENTS



JERUSALEM

# *PALESTINE JOURNAL OF BOTANY*

appears in two series

## *THE JERUSALEM SERIES (J)*

edited by the staff of the Department of Botany of the Hebrew University, Jerusalem. Four issues of JERUSALEM SERIES appear during the year, each number bearing the date of publication. The size of the annual volume of JERUSALEM SERIES varies from 300 to 400 pages.

## *THE REHOVOT SERIES (R)*

edited by H. R. OPPENHEIMER and I. REICHERT, Agricultural Research Station, Rehovot, Palestine. Two issues of REHOVOT SERIES appear during the year, each number bearing the date of publication. The size of the annual volume of REHOVOT SERIES varies from 200 to 250 pages.

*

*Correspondence concerning editorial matters* should be addressed for the JERUSALEM SERIES to D. V. ZAITSCHEK, P.O.B. 620, JERUSALEM, PALESTINE, for the REHOVOT SERIES to THE EDITORS, PALESTINE JOURNAL OF BOTANY, P.O.B. 15, REHOVOT, PALESTINE.

*

*Subscriptions* are payable in advance by crossed cheque or postal order and should be forwarded to the ADMINISTRATION of the PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, PALESTINE. The subscription price is

25 s. per annum, post free, for both series
18 s. per annum, post free, for JERUSALEM SERIES separate
12 s. per annum, post free, for REHOVOT SERIES separate
(single number 6 s., double number 12 s.).

*

*Business correspondence,* including notice of change of address, remittances, advertisements, etc. should be addressed to the ADMINISTRATION of the PALESTINE JOURNAL OF BOTANY, P.O.B. 620, JERUSALEM, PALESTINE.

---

Printed in Palestine
Azriel Press Jerusalem

# PALESTINE JOURNAL OF BOTANY

*Jerusalem Series*

JERUSALEM
P. O. B. 620
PALESTINE

# PALESTINE
# JOURNAL OF BOTANY

*Jerusalem Series*

EDITED BY

THE STAFF OF THE DEPARTMENT OF BOTANY OF THE HEBREW UNIVERSITY

VOLUME II

PAGES VI AND 252

WITH EIGHT PLATES AND NUMEROUS FIGURES IN THE TEXT

JERUSALEM
1940/42

PRINTED IN PALESTINE
AZRIEL PRESS, JERUSALEM

# INDEX OF AUTHORS



# INDEX OF SUBJECTS

*PALESTINE*
# *JOURNAL OF BOTANY*

Vol. II. No. 4 *Jerusalem Series* November 1942

## REVISION OF THE *ONOPORDON* SPECIES OF PALESTINE, SYRIA AND ADJACENT COUNTRIES

By A. EIG[1]

(With Plate VI and 28 figures in the text)

Boissier, in his Flora Orientalis (1875) reports for Palestine *Onopordon Sibthorpianum* Boiss. et Held. var. *alexandrinum* Boiss. only. For Syria he reports *O. illyricum* L., *O. illyricum* var. *libanoticum* Boiss., *O. ambiguum* Fresen., *O. heteracanthum* C.A.M. var. *anisacanthum* Boiss. and *O. cynarocephalum* Boiss. et Bl. Dinsmore, in the second edition of Post's Flora (1933), reports for Palestine: *O. illyricum* L., *O. flocossum* Boiss. var. *libanoticum* (Boiss.) Dinsm., *O. Sibthorpianum* Boiss. et Held., *O. Sibthorpianum* var. *alexandrinum* Boiss., *O. ambiguum* Fresen., *O. ambiguum* var. *horridum* Post, *O. heteracanthum* C.A.M., *O. anisacanthum* Boiss., *O. anisacanthum* var. *recurvatum* (Bornm.) Dinsm., *O. cynarocephalum* Boiss. et Bl. and *O. cynarocephalum* var. *abbreviatum* Bornm. Altogether 7 species and 4 varieties. For Syria Dinsmore reports: *O. illyricum, O. floccosum, O. ambiguum, O. heteracanthum, O. anisacanthum. O. anisacanthum* var. *recurvatum, O. cynarocephalum* and *O. polycephalum.* In all 7 species and 1 variety are accounted for. For Syria and Palestine together Dinsmore reports 8 species and 5 varieties.

The critical study of the Syrian and Palestinian species of this genus, made on the material of the Herbarium of the Hebrew University (Jerusalem) and of Herbier Boissier (Geneva) has to a great extent revised our knowledge of that genus of the countries concerned. It revealed also the fact that these countries are among the richest, if not the richest, in species of *Onopordon.*[2]

[1] Posthumous.

[2] Abbreviations in this paper: Collectors: *E=A. Eig, F=N. Feinbrun, Z=M. Zohary.* Districts of Palestine: A=Amman; CA=Carmel; CS=Coastal Plain of Shefela; G=Gilead; J=Judean Mountains; JD=Judean Desert; LJ=Lower Jordan Valley; NN=Near Negeb; S=Sharon; UG=Upper Galilee.

## *ENUMERATION*

**O. illyricum** L.-Sp. Pl. (1753) p. 1158.

N. SYRIA: El Ourdu, S. of Antiochia (1932 *Delbes*); betw. Bellad esh-Sheikh and el Ourdu, 15 km NE of Antiochia; Jebel Arbain, env. of Eriha, (all 1932, *EZ*).

The Syrian specimens of this species indubitably differ from the South European. Not having seen either the original specimen of LINNEE or any rich material of this species from European countries I must refrain from dealing with this question.

**O. cynarocephalum** Boiss. et Bl.-Boiss. Diag. Pl. Or. Nov., Ser. II, 3 : 48 (1856).

PALESTINE: CA: Carmel, near Haifa (1923 *E, Faktorovsky*); betw. Balfouria and Tel Adashim, (1926 *E*) SYRIA: Northern Lebanon: Wadi Hanufa, and betw. Sir and Kattine, (1934 *EFZ*).

**O. cynarocephalum** Boiss. et Bl. var. **albicans** Eig var. nov.

Folia utrinque, sed facie inferiore densius, araneoso hirsuta; tota planta albida, nec virens.

PALESTINE: Safed (1922 *E, Faktorovsky*); env. of Kinnereth (1924 *Smoly*).

**O. cynarocephalum** Boiss. et Bl. var. **patulum** Eig var. nov.

Phylla involucri patula, non imbricata; phyllorum pars superior longo-attenuata, (cum spina) 12-15 mm. longa.

PALESTINE: J: Jerusalem (1906 *Dinsmore*, sub O. illyrico).

A striking form which requires further study.

**O. cynarocephalum** Boiss. et Bl. ssp. **hierosolymitanum** Eig ssp. nov.

Differt ab O. cynarocephalo Boiss. et Bl.: involucri phylla araneoso-lanata; parte inferiore brevi, pars superior subito attenuata, (cum spina) parte inferiore prominente longior; totum araneoso-canescens.

PALESTINE: J: Jerusalem (1912 *Dinsmore*).

This form is very interesting. It differs considerably from *O. cynarocephalum* and I called it at first *O. hierosolymitanum*. But when I obtained specimens of the var. *patulum*, I noticed that this variety seems to link the ssp. *hierosolymitanum* on the one hand and *O. cynarocephalum* on the other.

In describing *O. cynarocephalum*, BOISSIER did not mention its affinity to *O. illyricum*. In his Fl. Or. (1875) he subdivided all the *Onopordon* species into two groups, placing *O. illyricum* in the group with scabrous pappus and *O. cynarocephalum* in the group with plumose pappus. This was certainly a mistake, as the pappus of *O. cynarocephalum* is scabrous, as well as that of *O. illyricum*. On the contrary, most of the Syrian material of *O. illyricum* possess rather plumose pappus. POST (1896) and DINSMORE (1933) failed to correct BOISSIER's error. Thus, *O. cynarocephalum* finds its nearest relative in *O. illyricum*, which it resembles very closely.

**O. carduiforme** Boiss.-Diag. Pl. Or. Ser. I, 10 : 92 (1849).

Pl. VI, 1, 2

PALESTINE: CS: Gedera (1924 *E*); S: Arsuf (1928 *EFZ*); Tira (near Haifa) (1924 *E*).

BOISSIER published this species in his Diag. Pl. Or. (1849) on the specimens that he collected near Gaza. Later on he changed his mind and in the Fl. Or. he identified *O. carduiforme* with *O. alexandrinum* (Diag. Pl. Or., I,

10 (1849), p. 93), which in its turn he reduced in the Fl. Or. to a variety of *O. Sibthorpianum*. A study of the original specimens and of our own material leads me to the following conclusions: (1) *O. alexandrinum* Boiss., *O. carduiforme* Boiss. and *O. Sibthorpianum* Boiss. et Held. are three "good" species; (2) *O. alexandrinum* belongs to a group of species characterized by the long scabrous-feathery or feathery pappus and ± long narrow spines of involucre; this group is principally an Irano-Turanian one; (3) *O. carduiforme* and *O. Sibthorpianum* are Mediterranean forms, characterized by the short scabrous pappus and flat spine.

**O. carduiforme** Boiss. ssp. **Blancheanum** Eig ssp. nov. Pl. VI, 3.

Differt ab *O. carduiformi*: Folia multo longiora, radicalia minus congesta; folii lobi minus congesti et minus tenue dissecti; capituli spinae longiores; achaenia angustiora et longiora.

Syria: Tripoli (1869, No. 345 bis *Blanche* sub O. libanotico); Kal'at esh Shkif (1924 *Smoly*); 74 km. SW of Damascus (1933 *EZ*).

A very prominent form. It seems to approach somewhat *O. libanoticum* Boiss. et Bl. according to its description (I have not seen it); but it differs from it by the deeply dissected leaves, etc. From *O. carduiforme* it is distinguished also edaphically. The latter species is a plant of sandy soils, whereas ssp. *Blancheanum* is rather a plant of heavy soils.

**O. telavivense** Eig sp.nov. Pl. VI, 5, 6; figs. 1, 2.

Planta biennis, 50-100 cm. alta. Caulis foliosus, ramosus, tota longitudine alatus, ± laxe papilloso-araneosus. Alae supra gla-


Figs. 1—28. (The figures marked by uneven numbers show the whole pappus and those with even numbers one bristle of pappus enlarged.)

| | | |
|---|---|---|
| 1, 2. | *Onopordon telavivense*: | Ain Hai (1925 *E*) |
| 3, 4. | *O. cyprium* | Type specimen |
| 5, 6. | *O. palaestinum* | Jerusalem, Univ. (1929 *E*) |
| 7, 8. | *O. anatolicum* | Lydia (1842 *Boiss.*) |
| 9, 10. | *O. alexandrinum* | Type specimen |
| 11, 12. | *O. anisacanthum* | Baalbek (1931 *Z*) |
| 13, 14. | *O. transjordanicum* | Type specimen |
| 15. 16. | *O. macrocephalum* | Hirbet Tmeiri (1927 *EFZ*) |
| 17, 18. | *O. canum* | Type specimen |
| 19, 20. | *O. heteracanthum* | Type specimen |
| 21, 22. | *O. syriacum* | Imtale (1932 *EZ*) |
| 23, 24. | *O. lanceolatum* | Type specimen |
| 25, 26. | *O. ambiguum* | Type specimen |
| 27, 28. | *O. jordanicolum* | Wadi Fara (1927 *EFZ*) |

brae vel subglabrae opacae, infra araneoso-hirsutae, inferiore caulis parte diametro caulis subaequales, crebre lobatae, lobis late triangularibus in spinam excurrentibus ; in summa caulis parte multo angustiores et profundius dissectae. Folia omnia supra glabra vel subglabra, opaca, infra indumento araneoso griseo-alba. Folia radicalia et caulina inferiora petiolata, oblonga, usque ad rhachidem pinnatipartita ; rhachis inter pinnas non, vel vix dentata ; pinnae distantes, oblongae vel lanceolatae, grosse et irregulariter inciso-dentatae, pinnarum lobi dentesque in spinam 3-5 mm. longam producti. Folia caulina media sessilia, oblongo-lanceolata, decurrentia, pinnatipartita, inter segmentes non dentata, segmentibus lanceolatis, integris vel 1-2 dentatis, in spinam 3-4 mm. longam abeuntibus. Folia caulina superiora sensim diminuta, anguste lanceolata, pinnatipartita, segmentibus triangulari-lanceolatis, spinosis. Capitula sine spinis 2-3 cm. diametro, globosa. Involucri phylla + araneosa, exteriora et media + patula vel recurva, exteriora lanceolata, sensim in spinam brevem producta ; phylla media lanceolata 2-3 cm. (cum spina) longa, in spinam superne planam plus minus abrupte attenuata ; phylla interiora lanceolata-linearia, sensim in spinam mollem angustata. Flosculi ca. 18 mm. longi. Pappus (6)-7-(8) mm. longus, rufescens, scaber. Achaenium 6 mm. longum, oblongum, subcompressum, 4-costatum, pluristriatum.

Palestine : CS : Tel-Aviv (1922 *E*, *Faktorovsky*) ; Shechunat Borochov (1926 *E*) ; Ekron (1924 *E*) ; S : Ain Hai (1925 *E*).

It is distinguished from *O. carduiforme* Boiss. by the different form of leaves, by taller growth of plant with more numerous heads, by sparser indumentum, by the somewhat smaller heads and shorter flowers.

The bristles of pappus are ca. 0,05 mm. thick and the side-hairs of the bristles ca. 0,05 mm. long.

**O. floccosum** Boiss.-Diag. Pl. Nov. Or., I, 10 : 92 (1849).

Pl. VI, 4.

Boissier published this species in 1849 on the specimens from Ehden, Lebanon, collected by Boissier himself. In the Fl. Or. (1875) he regarded this species as a synonym of *O. libanoticum* Boiss. et Bl., which in its turn he connected with *O. illyricum* as its var. *libanoticum*. I must go back to Boissier's view of 1849. The study of the original specimens of *O. floccosum* led me to the conclusion that this is quite a different species from *O. illyricum*. Furthermore it is evident from the description (unfortunately in the Herbarium of Boissier, I was unable to find the two typical specimens of *O. libanoticum* mentioned in the Diag. Pl. Or., II, 3, 1856, p. 48) that *O. libanoticum* is also an independent species and at all events, even if it is to be united with *O. flocossum*, the name of the latter must be chosen. Of the 5 specimens mentioned in the Fl. Or. for *O. illyricum* var. *libanoticum* I found in the Herbarium of Boissier only 4 and ascertained besides, that apart from the original specimens of Boissier from Ehden, those of Blanche from Ehden and of Kotschy from Garbi are also *O. flocossum*. The specimen of Blanche from Tripoli belongs to *O. carduiforme* (viz. its ssp. *Blancheanum*). I did not find the specimen of Blanche from Hasrun in Boissier's Herbarium.

**O. floccosum** Boiss. var. **longipapposum** Eig var. nov.

Pappus 15 mm., nec 8-10 mm. longus ; flosculi longiores.

Lebanon : Jebel Sanin (1897 *Bornmueller* No. 816 sub. O. heteracan-

1. *Onopordon carduiforme* Boiss; lower cauline leaf of type specimen.
2. *O. carduiforme* Boiss; radical leaf, Gedera (1924 *E*).
3. *O. carduiforme* ssp. *Blancheanum* ssp. nov. radical leaf. Syria, 74 km SW of Damascus (1933 *EZ*).
4. *O. flocossum* Boiss.; type specimen (Ky. 566).
5, 6. *O. telavivense* sp. nov.; cauline leaf. Shechunath Borochov (1926 *E*).
7, 8. *O. cyprium* sp. nov.; cauline leaf; type specimen.
9. *O. syriacum* Holmb.; cauline leaf; type specimen.
10. *O. anatolicum* Boiss. et Held.; cauline leaf. Turkey: Lydia, Laodicea (1842 *Boissier*).
11. *O. Sibthorpianum* Boiss. et Held.; cauline leaf; type specimen.
12. *O. horridissimum* sp. nov.; radical leaf; type specimen (Transjordania, env. of Sahab 1927 *EFZ*).
13. *O. jordanicolum* sp. nov.; cauline leaf. Palestine, Wadi Kelt (1930 *FZ*).
14. *O. palaestinum* sp. nov.; cauline leaf. Palestine, Judean Desert, Wadi el Habis (1934 *EF Grizi*).
15. *O. transjordanicum* sp. nov.; cauline leaf. Palestine, Gilead, Hirbet Tmeiri (1927 *EFZ*).
16. *O. macrocephalum* sp. nov.; cauline leaf. Palestine, Gilead, Hirbet Tmeiri (1927 *EFZ*).
17. *O. lanceolatum* sp. nov.; cauline leaf; type specimen.

thum C.A.M. var. violaceum var. nov.); Zebedani, (1855 *Kotschy* No. 566).

The group of forms: *O. carduiforme*, its ssp. *Blancheanum*, *O. telavivense*, *O. flocossum* and *O. libanoticum* (as mentioned, I did not see either the original or any other specimens of this last) constitutes a series of related forms which require further study on more fresh and abundant material. At any rate this group has no near affinities either to *O. illyricum* or to *O. alexandrinum* or *O. Sibthorpianum* as assumed by Boissier, Post, Dinsmore and others. It is a Mediterranean Syrio-Palestinian group, characterized by the short scabrous pappus and short flattish upper part of the involucre leaves. Ecologically they seem to be well differentiated: *O. floccosum* (and *O. libanoticum*, if a separate species) is a species of the high Lebanon Mountains; *O. carduiforme* is a species of the light soils of the coastal plain of Palestine; its ssp. *Blancheanum* is a plant of heavy soils in northern Palestine and southern Lebanon and Syria; finally *O. telavivense* is a plant of the heavy soils in the coastal plain of Palestine.

**O. cyprium** Eig sp. nov. Pl. VI, 7, 8; figs. 3, 4.

syn. *O. Sibthorpianum* ssp. *anatolicum* Holmboe (1914); non *O. anatolicum* Boiss. et Held.

Biennis, 25-30 cm. alta. Caulis foliosus, simplex, tota longitudine alatus, papilloso-araneosus. Alae in lobis mediocribus, in spinam excurrentes, dissectae. Folia lanceolata usque anguste oblongo-lanceolata, caulina inferiora et media breviter petiolata, superiora sessilia, omnia subtus tomentoso-cana, supra opaca, pinnatisecta, pinnae oblongae subremotae, inciso-dentatae, pinnarum lobi dentesque in spinam 2-5 mm. longam producti. Capitula sine spinis 2 cm. diametro, depresso-globosa. Involucri phylla exteriora et media ± patula vel recurva, margine minute scabridulo, e basi latiore oblonga, parte araneoso-tomentosa, abrupte contracta et in spinam abeuntia, media 2,5-3,5 cm. longa; phylla interiora lanceolato-linearia, margine minuto et parte scabridulo, sensim in spinam mollem angustata. Flosculi 20-25 mm. longi. Pappus 6-7 mm. longus, rufescens, scaber.

Cyprus: Betw. Bellapais and Kyrenia (1880 *Sintenis* et *Rigo* sub O. Sibthorpiano).

The bristles of the pappus are ca. 0,07 mm. thick and their side-hairs ca. 0,06 mm. long.

The nearest species are *O. Sibthorpianum* Boiss. et Held. and *O. carduiforme* Boiss. It is easily distinguished from the former by the pinnatisect leaves (Cf. Pl. VI, 7, 8 with 11) and from the latter (with which it possesses in common pinnatisect leaves) by the much narrower spines of the involucre leaves etc.

In the Herbier Boissier this species is placed in the cover of *O. Sibthorpianum* var. *anatolicum*, but labelled *"O. Sibthorpianum"*. Holmboe, who worked on the *Onopordon* species of Cyprus in the Herbier Boissier, did not notice the great difference in leaves, pappus, etc. between this plant and *O. anatolicum*, and reported it (1914) as *O. Sibthorpianum* ssp. *anatolicum*, without, however, giving any description of this subspecies. Thus, besides *O. elatum* S. et S. and *O. illyricum* L., reported from Cyprus by Holmboe, the following three endemic species grow there: *O. Boissieri* Freyn et Sint., *O. insigne* Holmboe and *O. cyprium* Eig, each known only from one locality. It seems to me that further study of the *Onopordon* species of Cyprus may prove very profitable.

**O. alexandrinum** Boiss.-Diag. Pl. Or. Nov., I, 10:93 (1849). Figs. 9, 10.

Palestine: NN: Beersheba (1922 *E*); there, (1929 *EFZ*); env. of Qurnub (1934 *EFZ*).

Boissier described this species from the specimens of Cadet de Fontenay (Alexandria). In Flora Orientalis (1875) he reduced this species to a variety of *O. Sibthorpianum* Boiss. et Held., which is not justified, as the latter, despite its outward resemblance belongs to another group of species. In the Fl. Or. Boissier included into *O. Sibthorpianum* also the species *O. carduiforme* Boiss. and *O. anatolicum* Boiss. et Held. This, however, is only another mistake, both of them being "good" species.

Our specimens from the Negeb show transitional characteristics to *O. palaestinum* Eig. These probably form a separate variety, which may be proved only by means of more abundant material of this species from Egypt and Palestine. *O. alexandrinum* is easily distinguished from *O. Sibthorpianum, O. carduiforme* and other species of this Mediterranean group by its pappus which is ca. 15 mm. long; the single bristles are ca. 0,07 mm. thick and their side-hairs ca. 3 mm. long.

**O. palaestinum** Eig sp. nov. Pl. VI, 14; figs. 5, 6.

Bienne, 50-120 cm. altum, totum plus minus cano-tomentosum, caulibus ramosis, tota eorum et ramorum longitudine alatum. Alae inferne latiores, superne angustiores, in lobis in spinam excurrentes dissectae vel partitae. Folia radicalia et caulina inferiora petiolata, lato-oblonga, vel ovato-oblonga, profunde pinnatipartita; pinnae oblongae, confluentes vel remotae, inciso-dentatae, pinnarum lobi dentesque in spinam 2-7 mm. longam producti. Folia caulina media sessilia, oblongo-lanceolata, decurrentia, pinnatipartita, dense et crebre spinulosa. Folia caulina superiora valde diminuta, angusto-lanceolata, pinnatipartita, densissime spinulosa. Capitula sine spinis 3 cm. diametro, depresso-globosa. Involucri phylla ± araneosa et glandulis sessilibus obsita, exteriora et media ± patula vel recurva, e basi latiore oblonga abrupte contracta et in spinam flavescentem abeuntia, media 3-4 cm. longa; phylla interiora lanceolato-linearia, sensim in spinam mollem angustata. Flosculi 28-33 mm. longi. Pappus 16-18 mm. longus, scabrido-plumosus. Achaenium 5-6 mm. longum, 2½-3 mm. latum.

Palestine: J: Jerusalem, University Grounds (1935, 1929 both *E*); Jerusalem, Gai Ben Hinom (1924 *E, Faktorovsky*). JD: Wadi el-Habis, E of Taibeh (1934 *EF Grizi*); 8 km. E of Jerusalem (1934 *EFZ*); Wadi Saif (1934 *Z*); Wadi Abu-Hindi (1932 *E*).

The single bristles of the pappus in this species are ca. 0,05 mm. thick and their side-hairs ca. 0,15 mm. long.

The nearest species is *O. anatolicum* Boiss. et Held., described below. It is distinguished from *O. anatolicum* by the longer and more numerous spines of the leaves and stems, by the non (or scarcely) scabrous margins of the involucre leaves, somewhat longer pappus with somewhat shorter side-hairs, less acuminate and rather more dissected leaves, taller growth, etc. Besides, *O. anatolicum* seems to be an Eu-Mediterranean species, and *O. palaestinum* is an Irano-Turanian plant penetrating into the adjacent Mediterranean districts. From *O.alexandrinum*, which *O. palaestinum* closely resembles in habitus it is easily distinguished by the much shorter and denser side-hairs of the pappus-bristles and by the less profoundly dissected leaves, broader lower leaves, taller growth, etc.

**O. anatolicum** (Boiss. et Held.) Eig Pl. VI, 10; figs. 7, 8.

syn. *O. anatolicum* Boiss et Held. (nomen in Herb.), *O. Sibthorpianum* var. *anatolicum* Boiss. Fl. Or. 3 (1875); non *O. Sibthorpianum* ssp. *anatolicum* Holmb. Veg. Cyprus (1914).

Bienne, 25-40 cm. altum, totum cano-tomentosum, caulibus ramosis, tota eorum et ramorum longitudine alatum, alae in lobis in spinam excurrentes dissectae vel partitae. Folia radicalia ignota ; caulina inferiora breviter petiolata, media et superiora sessilia, decurrentia ; folia caulina inferiora et media lanceolata usque oblongo-lanceolata, pinnatipartita vel pinnatilobata, pinnae oblongae, remotae, inciso-dentatae vel integrae, pinnarum lobi dentesque in spinam 2-5 mm. longam producti ; folia caulina superiora valde diminuta, anguste-lanceolata, spinuloso-dentata vel spinuloso-pinnatipartita. Capitula sine spinis 2-2½ cm. diametro, depresso-globosa. Involucri phylla exteriora et media ± patula vel recurva, margine scabro, e basi latiore oblonga, araneoso tomentosa, abrupte contracta et in spinam abeuntia, media 2½-3 cm. longa ; phylla interiora lanceolato-linearia, margine scabro, sensim in spinam mollem angustata. Flosculi 25-30 mm. longi. Pappus 12-14 mm. longus, scabrido-plumosus. Achaenium 5-5½ mm. longum, 2½ mm. latum.

Turkey : Pisidia, près de Beychehr (1845 *Heldreich*) ; Lydia, Laodicea (1842 *Boiss.*).

The single bristles of the pappus in this species are ca. 0,05 mm. thick and their side-hairs ca. 0,18 mm. long.

The nearest species is *O. palaestinum* from which it is distinguished by the shorter and less numerous spines of the leaves and stems, by the clearly scabrous margins of the involucre-leaves, by the more delicate spines, somewhat shorter pappus and somewhat longer side-hairs of the pappus bristles, acuminate and somewhat less dissected leaves and in lower growth. By its pappus, etc. it is easily distinguished from *O. Sibthorpianum* Boiss. et Held. and *O. insigne* Holmb.

Of the specimen mentioned in Fl. Or. as *O. Sibthorpianum* var. *anatolicum* I found in the Herbier Boissier only those from Lydia of Boissier and those from Pisidia of Heldreich. I did not find the specimens of Balansa there. One of the specimens of Heldreich possesses leaves much smaller and less dissected.

In the Herbier Boissier I found under the same name specimens of Sintenis and Rigo from Cyprus (No. 545), mentioned by Holmboe (1914) as *O. Sibthorpianum* ssp. *anatolicum*. This plant does not belong to the circle of forms both of *O. anatolicum* and *O. Sibthorpianum* and is a new species (*O. cyprium m.*).

**O. syriacum** Holmboe -Bul. Herb. Boiss., 2-me Série, 7 : 827 (1907). Pl. VI, 9, figs. 21, 22.

Syria : Imtale, near Damascus (1932 *EZ*) ; env. of the village Jirijir, on the eastern slopes of the Antilebanon (1932 *EZ*).

The pappus of this species is 17 mm. long ; its single bristles are ca. 0,06 mm. thick and their side-hairs ca. 0,18 mm. long.

Although published 20 years ago this species remained little known and Dinsmore did not include it in the second edition of Post's Flora. Like the original specimens of Boissier and Blanche ours are also from the environs of Damascus, the second locality being farther to the north. It is the species which has been confused with *O. ambiguum* Fresen, reported by different authors from Syria. The latter is well distinguished from *O. syriacum* (Cf. figs. 21, 22 with figs. 25, 26) and must be excluded from the list of Syrian species.

**O. anisacanthum** Boiss.-Diag. Pl. Or. Nov., I, 10 : 93 (1849). Figs. 11, 12.

Palestine : A ; betw. el Yaduda and Umm el Ammad (1936 *E*). Syria :

Antilebanon: Near Baalbek (1931 Z locus classicus!); betw. Deir Atieh and Jirijir (1932 EZ). Middle Syria: 28 km. W of Selemié (1933 EZ).

The flowerets of the specimens from Ba'albek are 40-42 mm. long, the lower (narrower) part being somewhat longer than the upper; the pappus is plumous, 20 mm. long, white, the akens (young) are 5 mm. long, prismatic-oblong; the lower part of the intermediate scales of involucre is about 15 mm. long and 4-5 mm. broad, tapering rather gradually to the upper somewhat triquetrous part, which, together with the spine, is 35-40 mm. long. In the specimen from Deir Atieh-Jirijir the flowerets are only 32-33 mm. long, the pappus about 18 mm. long as in the original specimen of Boissier and the intermediate scales together with the spine, 50-52 mm. long. The single bristles of the pappus are in this species ca. 0,04 mm. thick and their side-hairs ca. 0,15 mm. long.

**O. lanceolatum** Eig sp. nov. Pl. VI, 17; figs. 23, 24.

Bienne, humile, 30 cm. altum, basi ramosum, caulibus simplicibus, monocephalis, foliolosis, tota longitudine alatis, ± araneoso-tomentosis, viridibus. Alae utrinque araneoso-tomentosae, vix lobatae, multispinosae, spinis 4-8 mm. longis; alae inferiore caulis parte diametro caulis subaequales, in summa caulis parte multo angustiores. Folia utrinque araneoso-tomentosa, radicalia ignota, caulina omnia sessilia, lanceolata, decurrentia, lobato-dentata, lobae dentesque in spinam 4-8 mm. longam productae; folia suprema vix vel non dentata, valde diminuta, lanceolato-subulata. Capitula 3½-4½ cm. lata, ovato-globosa, subtus concava. Involucri phylla ± araneoso-tomentosa, minute serrulata, inferiora et media ± patule recurva, inferiora oblongo-lanceolata, 13-15 mm. longa, in spinam brevem abeuntia; phylli medii pars inferior oblonga, ca. 15 mm. longa et 5-7 mm. lata, sensim in partem superiorem triquetro-planam, (cum spina) 30-37 mm. longam, attenuata; phylla interiora lineari-lanceolata, sensim attenuata, in mucronem non vulnerantem abeuntia. Flosculi ca. 30 mm. longi, pars superior dilatata, inferiore subsesqui brevior. Pappus albus, 12-14 mm. longus, scabro-plumosus, seta unica longior. Achaenia (non satis matura) triquetro oblonga, 6 mm. longa, subcompressa, multistriata.

Syria: Hauran, betw. el Michrife and Tell i Omeri (1932 EZ).

In this species the single bristles of the pappus are ca. 0,04 mm. thick and their side-hairs 0,18 mm. long.

The nearest species is *O. anisacanthum* Boiss. *O. lanceolatum* is distinguished from it by the absence of the subtending bracts, by the shorter lanceolate leaves of the stem, recurved at the apex, by the low growth, by somewhat longer side-hairs of the pappus, etc. The relationship between *O. anisacanthum* and *O. lanceolatum* is still to be studied on more abundant material of the latter. It is distinguished from *O. transjordanicum* Eig by its pappus, scales, etc. and from *O. syriacum* Holmboe by the much larger heads, by the leaves, pappus, etc.

**O. canum** Eig sp. nov. Figs. 17, 18.

Bienne, elatum, caulibus foliosis, tota longitudine angusto-alatum, dense cano-tomentosum. Alae lobato-spinosae, spinis flavis 3-6 mm. longis. Folia inferiora ignota, superiora lanceolata, sessilia, decurrentia, dentato-lobata, lobi et interdum margines

inter lobos in spinam 3-6 mm. longam producti ; folia suprema valde diminuta, anguste lanceolato-linearia, integra. Capitula magna, sine spinis 5 cm. diametro, depresso-globosa. Involucri phylla exteriora et media dense araneoso-cana, margine scabridulo, + patula vel recurva, e basi latiore et oblonga abrupte contracta et in spinam brevem abeuntia, media 2,5-3 cm. longa ; phylla interiora lanceolato-linearia, margine scabridulo, sensim in spinam mollem angustata, 3,5-4 cm. longa. Flosculi 4 cm. longi. Pappus albus, 25-27 mm. longus, plumosus.

S.E. Iraq : Mandali (1930 *Guest*, sub O. heteracantho).

The single bristles of the pappus in this species are ca. 0,06 mm. thick and their side-hairs ca. 0,40 mm. long.

The nearest species seems to be *O. heteracanthum* C.A.M. *O. canum* is easily distinguished from the latter by its longer pappus and longer side-hairs (compare figs. 17, 18 with figs. 19,20), by recurved involucre leaves, less numerous subtending bracts, etc. It is also easily distinguished from *O. transjordanicum* Eig and *O. anisacanthum* Boiss. by its involucre leaves and pappus.

**O. transjordanicum** Eig sp. nov. Pl. VI, 15 ; figs. 13, 14.

Bienne, humile, 35-50 cm. altum, ramosum caulibus foliosis tota longitudine angusto-alatis, araneoso albo-tomentosis. Alae lobato-spinosae, spinis densis, flavis, 3-10 mm. longis. Folia inferiora petiolata, angusto-oblonga, pinnatiloba et pinnatipartita, pinnis dentatis, spinulosis ; folia caulina media sessilia, decurrentia, lineari-lanceolata, dentato-spinulata. Capitula 3-4,5 cm. lata, subglobosa, subtus paulum concava. Involucri phylla subinflata, + araneoso-tomentosa, demum subglabra, media et inferiora + patule recurva ; phylla inferiora oblongo-lanceolata, acuminata, 15-25 mm. longa, in spinam brevem abeuntia ; phylli medii pars inferior ovato-oblonga, ca. 15 mm. longa et 6-8 mm. lata, in partem phylli superiorem triquetro-linearem (cum spina) 18-23 mm. longam subito attenuata ; phylla interiora lineari-lanceolata, 35-40 mm. longa, in mucronem non vulnerantem sensim attenuata. Flosculi 4 cm. longi. Pappus albo-sordidus, ca. 25 mm. longus, scabro-plumosus. Achaenia obovato-oblonga, 5 mm. longa.

Palestine : G : env. of Hirbet Tmeiri (1927 *EFZ*).

In this species the single bristles of the pappus are 0,05 mm. thick and their side-hairs ca. 0,25 mm. long.

It is distinguished from *O. anisacanthum* Boiss. by the lack of the involucral bracts at the base of the heads, by the subinflated scales of the involucre, by the less divided leaves, scantier hair, much shorter pappus and shorter side-hairs of the pappus, etc. It is distinguished from *O. macrocephalum* by its greater height, the less divided leaves, smaller heads, different form of scales, and in that the inner scales are longer than the intermediate, etc. It is distinguished from *O. syriacum* by its longer pappus, larger heads, stronger spines, etc.

**O. macrocephalum** Eig sp. nov. Pl. VI, 16 ; figs. 15, 16.

Bienne, humile, simplex vel e basi paulum ramosum, caulibus monocephalis. Caules foliosi tota longitudine angusto-alati, araneoso-tomentosi. Alae lobato-spinosae, spinis densissimis, flavis, 3-8 mm. longis. Folia undique, sed facie superiore densius,

araneoso-albo-tomentosa, radicantia et inferiora caulina breviter petiolata, oblongo-lanceolata, pinnatipartita, recta, inter pinnas spinulosa, pinnae aproximatae, dentato-spinulosae; folia caulina media lanceolata, sessilia, decurrentia, dentato-lobata, dense spinulosa vel dentato-spinulosa, folia superiora valde diminuta, vix vel non spinulosa, 2-3 suprema phyllis involucri similia, subcapitalia. Capitula 5-6 cm. lata, subglobosa, subtus paulum concava. Involucri phylla subinflata, + araneoso-tomentosa, demum subglabra, media ± patule recurva; inferiora oblongo-lanceolata, 18-22 mm. longa, in spinam brevem abeuntia; phylli medii pars inferior oblonga vel ovato-oblonga, 15-20 mm. longa et 6-9 mm. lata, in partem superiorem triquetro-inflatam, carinatam (cum spina) 25-40 cm. longam sensim attenuata; phylla interiora lineari-lanceolata in mucronem non vulnerantem sensim attenuata. Flosculi 3-4 cm. longi. Pappus albus, 20-22 mm. longus, scabro-plumosus. Achaenia (non satis matura) obovato-oblonga 6 mm. longa multistriata.

PALESTINE: G: es Salt to Amman (1924 *Dinsmore*); Hirbet Tmeiri (1927 *EFZ*); J: Jerusalem (1938 *D. Zohary*). SYRIA: Betw. Damascus and Azra (1931 *Z*); S of Damascus, betw. Saoura Kbira and Haidjane (1932 *EZ*).

In this species the single bristles of the pappus are 0,05 mm. thick and their side-hairs ca. 0,35 mm. long.

It is distinguished from *O. anisacanthum* Boiss. in being a shorter plant, by its bigger heads, more robust spines with the lower part broader and longer and the upper part proportionally shorter, and in that the upper part of the involucre leaves are rather spongy, the outer involucre leaves longer and their spine shorter, not being recurved at all, by the dissected leaves, longer pappus, etc.

It is distinguished from *O. lanceolatum* and *O. syriacum* by its leaves. Its nearest relative on the one hand is *O. transjordanicum* and on the other *O. horridissimum*, especially the latter. It is distinguished from the first by being a shorter plant, by the more divided leaves, bigger heads, by the prominent keel of the spines and their different form, by the longer side-hairs of the pappus, etc. It is distinguished from *O. horridissimum* in being a taller plant with smaller leaves, shorter spines of the wings and leaves, etc.

**O. horridissimum** Eig sp. nov. Pl. VI, 12.

Bienne, breviter caulescens vel subacaule e basi ramosum, caulibus brevissimis, monocephalis. Caules dense foliati, inter folias alati, araneoso-albo-lanati. Alae (sine spinis) continuae, densissime et longissime spinulatae, spinis 15-20 mm. longis, flavis. Folia utrinque araneoso-albo-lanata, dense et longe spinulosa; folia inferiora magna, 20-30 cm. longa, oblonga, e basi dilatata, pinnatipartita, margine inter pinnas et pinnis crebre et irregulariter lobato-dentatis, longe spinulatis; folia caulina ut folia inferiora, sed angustiora, lanceolata, decurrentia; folia nonnula superiora valde diminuta, 1-3 suprema phyllis similia, vix vel non spinulata. Capitula magna, juvenalia 5-6 cm. lata. Involucri phylla subinflata, + araneoso-tomentosa, media ± patule recurva; inferiora 30-35 mm. longa, oblongo-lanceolata, in spinam brevem sensim attenuata; phylli medii pars inferior ovato-oblonga, 15-20 mm. longa et 8-11 mm. lata, in partem superiorem triquetro-

inflatam, carinatam, (cum spina) 34-45 mm. longam ± abrupte attenuata ; phylla inferiora lineari-lanceolata, in mucronem non vulnerantem sensim attenuata.

Palestine : A : env. of Sahab (1927 *EFZ*), 10 km. S of Amman (1936 *EFZ*).

The specimens which we posses are unfortunately too young for complete description, their specific independence is therefore still in doubt. It is fairly certain that *O. horridissimum* is close to *O. macrocephalum*, with which it has in common large heads and strong, inflated, fungous spines, but even in its young state *O. horridissimum* is easily distinguished from *O. macrocephalum* in being a still lower plant, branching from the base, by the very large leaves, higher than the plant itself, by the very numerous, dense and long spines of the wings and leaves and in that the scales of involucre are still stronger and their upper part longer. Nevertheless further study may prove that *O. horridissimum* is only a subspecies of *O. macrocephalum* (*O. macrocephalum* ssp. *horridissimum*).

**O. jordanicolum** Eig sp. nov. Pl. VI, 13 ; figs. 27, 28.

Bienne, elatum, paulum ramosum, undique araneoso-hirsutum, demum subglabrum, viride. Alae, praeter partem caulis superiorem, diametro caulis latiores vel subaequales, sinuato-spinulosae, spinulis remotis brevibus vix vulnerantibus. Folia inferiora petiolata, late ovato-lanceolata, grosse lobato-dentata, lobi dentesque in spinam 1-3 mm. longam vix vulnerantem producti ; folia caulina media ut inferiora, sed late lanceolata, sessilia, decurrentia ; folia caulina superiora valde diminuta, lanceolata, lobato-dentata, lobi foliorum inferiorum lobis multo minores. Capitula globosa, depressa, sine spinis 4-5 cm. lata. Involucri phylla + araneoso-villosa, demum subglabra, superiora (infima) patula, caetera ± recurva vel omnia recurva ; inferiora et media e basi ovato-oblonga vel oblonga, 7-12 mm. longa et 4-6 mm. lata, parte superiore (cum spina flava 3-4 mm. longa) eis sesqui- vel minus longiore, subito attenuata, interiora lineari-lanceolata, longe et sensim attenuata, in spinam non vulnerantem abeuntia, 28-32 mm. longa. Flosculi 30-35 mm. longi. Pappus 18-22 mm. longus, plumosus, rufescens. Achaenium (juvenale) oblongum, 5 mm. longum, compressum, multistriatum.

Palestine : LJ : Lower slopes of the mountains at the mouth of Wadi Fara (1927 *EFZ*); Wadi Kelt (1930 *FZ*); Wadi Milh (1935 *Dinsmore*); Wadi Nimrin (1936 *EFZ*).

**O jordanicolum** Eig var. **spinulosum** Eig var. nov.

Spinulae alarum et foliorum duplo-triplo longiores et plus congestae.

Palestine : LJ : Wadi Fara (1935 *Dinsmore*).

In this species the single bristles of the pappus are 0,07 mm. thick and their side hairs ca. 0,25 mm. long.

Of the Palestinian *Onopordon* few forms only of *O. cynarocephalum* possess leaves approaching those of *O. jordanicolum* but the latter is definitely not a near relative of *O. cynarocephalum*.

According to our revision the list of Palestinian *Onopordon* thus comprises the following species: *O. cynarocephalum* Boiss. et Bl., *O. cynarocephalum* var. *albicans* var. nov. and var. *patulum* var. nov. *O. cynarocephalum* ssp. *hierosolymitanum* ssp. nov., *O. carduiforme* Boiss., *O. telavivense* sp. nov., *O. alexandrinum* Boiss., *O. palaestinum* sp. nov., *O. anisacanthum* Boiss., *O. transjordanicum* sp. nov., *O. macrocephalum* sp. nov., *O. horridissimum* sp. nov., *O. jordanicolum* sp. nov. In all 10 species, 1 subspecies and 2 varieties. This is the complete list of Palestinian *Onopordon*. Thus only two of the seven species mentioned by Dinsmore for Palestine (viz. *O. cynarocephalum* and *O. anisacanthum*) are to be retained.

The list of Syrian *Onopordon* species according to our revision is as follows: *O. cynarocephalum* Boiss. et Bl., *O. illyricum* L., *O. carduiforme* Boiss. ssp. *Blancheanum* ssp. nov., *O. floccosum* Boiss., *O. floccosum* var. *longipapposum* var. nov., *O. anisacanthum* Boiss., *O. syriacum* Holmb., *O. lanceolatum* sp. nov., *O. macrocephalum* sp. nov.— *O. libanoticum* Boiss. et Bl., of which I did not see any specimen, seems to me to be a "good" species. I also did not see specimens of *O. polycephalum* from Syria,, though Post reports it from Amanus Mts.. Thus the complete list of Syrian species of *Onopordon* consists also of 10 species, 5 mentioned by Dinsmore.

The full list of Syrian-Palestinian *Onopordon* species consists thus of 16 species, 2 subspecies and 3 varieties.

I wish to add some general phytogeographical-systematical remarks concerning the Palestinian and Syrian *Onopordon*. The size and structure of the pappus is one of the most important characteristics for the specific distinction within this genus. As a rule in *Onopordon* species of Palestine and Syria, the length of the pappus and of the side-hairs of individual pappus-bristles (i.e. the more or less prominent scabrosity or plumosity of the pappus) increases as we proceed to more arid districts. The shortest scabrous pappus is peculiar to the series of the following Eu-Mediterranean species: *O. carduiforme, O. carduiforme* ssp. *Blancheanum, O. telavivense, O. floccosum* (and *O. libanoticum* ?). To this series also belongs *O. cyprium* described in this paper, and at least *O. Sibthorpianum* from Greece, which has frequently been confused with different species from Egypt, Palestine and Syria. The Eu-Mediterranean *O. cynarocephalum* also possesses a short pappus and comparatively short side-scabrosity of the bristles. The Eu-Mediterranean *O. illyricum* (the Syrian forms !) belonging to the series of *O. cynarocephalum* possesses, a short pappus too, but this pappus is rather plumous and not scabrous. *O. polycephalum* is a definite exception to this rule, however, belonging to another series. This plant although apparently an Eu-Mediterranean species, possesses a rather long pappus with long-plumous bristles. All of these show still another morphological "Mediterranean" characteristic, viz. the comparatively small

size of the involucre leaves which are more or less gradually contracted to a spine ; these are small-headed species principally.

The Irano-Turanian and Irano-Turanian-Saharo-Sindian group of species is more numerous and is characterized by the long, ± plumous or feathery pappus, often by the long and strong involucre scales, suddenly contracted into a long spine ; principally these are big-headed species. One series of this group consists of the following species : *O. anisacanthum, O. lanceolatum, O. syriacum, O. transjordanicum* and the Sinai species *O. ambiguum. O. macrocephalum* and *O. horridissimum* also belong to this series apparently. As a rule the farther we proceed from the northern Irano-Turanian districts of Syria to the Irano-Turanian and Saharo-Sindian districts of Transjordan and Sinai, the bigger the heads and the longer the pappus and its side-hairs. The Transcaucasian and North-Persian *O. heteracanthum* C.A.M. and the Iraqian *O. canum* Eig also belong to this group of species. The second series of this Irano-Turanian group consists of the following species : *O. alexandrinum* and *O. palaestinum.* Ecologically these are Irano-Turanian species on the border of the Mediterranean territory. Morphologically they are distinguished from those of the first series by the smaller involucre scales. In Turkey the second series includes *O. anatolicum* also, but this seems to be principally a Mediterranean species.

The most interesting Palestinian species is without doubt *O. jordanicolum.* Geographically it is a Saharo-Sindian species of the Lower Jordan Valley. It grows there, however, at the mouths of wadis only. By its pappus it belongs to the Irano-Turanian group, by the scales of involucre to the Mediterranean. It is the only Palestinian species, Saharo--Sindian at that, with almost entire leaves. Systematically it stands quite alone among the Palestinian and Syrian species of this genus. It seems to belong to the group of paleogenic endemics of Palestine. But this is an exceptional case as the other endemic species of *Onopordon* from these countries seem to be rather neoendemic. The process of formation of forms is apparently even now at its full development here.

From what I have observed in the large European herbaria as well as from my study of the material of our own Herbarium I am of the opinion that a new revision of the whole genus would be very desirable.

*Key to the Palestinian species of* Onopordon

1. Pappus scabrous, 5-12 mm. long; the upper narrower part of the involucre scales ½-2 cm. long. ..... 2

— Pappus plumous or feathery, rarely scabrous, 14-25 mm. long; narrow part of the involucre scales generally longer than 2 cm..... 4

2. The scales of involucre are adpressed, rarely somewhat patulous, never recurved, generally gradually tapering into a short mucro. Tall plants with heads of 3-7 cm. in diameter, lower leaves large, pinnatilobed. Mediterranean territories .. *O. cynarocephalum*

— The scales of involucre, or some of them, are ± recurved; their upper part is ± suddenly contracted and produced into a mucro; all the leaves pinnatisect or pinnatipartite ..... 3

3. Plants 20-40 cm. high; all the leaves deeply pinnatisect up to the rachis; plants of light soils of the Coastal Plain (Pl. VI, 1, 2) ..... *O. carduiforme*

— Plants 50-100 cm. high; leaves, especially the upper ones pinnatiparted only. Plants of heavy soils of the Coastal Plain (Pl. VI, 5, 6; figs. 1, 2) ..... *O. telavivense*

4(1). All the leaves pinnatisect. Low plants (10-25 cm. high) with heads 5-10 cm. broad; intermediate scales 5-7 cm. long, somewhat spongy with prominent keel on the upper face. Plants of Transjordan ..... 5

— The lowermost leaves at least pinnatipartite or pinnatilobed..... 6

5. Leaves 25-30 cm. longer or as long as the stem; plant nearly stemless branching from the base (Pl. VI, 12) ..... *O. horridissimum*

— Leaves smaller; plant taller, not branching from the base (Pl. VI, 16; figs. 15, 16) ..... *O. macrocephalum*

6(4). Leaves large, ovate, greenish, lobed; wings of the stems wider or as wide as the diameter of the stems; head 4-5 cm. in diameter; spines of the head 1-1½ cm. long. Wadis of the Lower Jordan Valley (Pl. VI, 13; figs. 27, 28) ..... *O. jordanicolum*

— Plants with other characters ..... 7

7. Flowers 35-40 mm. long. Plants of the steppes of Transjordan ..... 8

— Flowers 20-25 mm. long ..... 9

8. Heads subtended by some upper, linear, scaly leaves. Pappus 15-18 mm. long (Figs. 11, 12) ..... *O. anisacanthum*

— Heads not subtended by scales. Pappus 22-25 mm. long. (Pl. VI, 15; figs. 13, 14) ..... *O. transjordanicum*

9. Upper leaves at least pinnatisect; pappus clearly plumose. Negeb (Figs. 9, 10) ..... *O. alexandrinum*

— All the leaves pinnatipartite or pinnatilobed; pappus rather scabrous. Judean Desert and adjacent districts (Pl. VI, 14; figs. 5, 6) ..... *O. palaestinum*

# THE VEGETATIONAL ASPECT OF PALESTINE SOILS

## A preliminary account of the relations between vegetation and soils in Palestine

By M. ZOHARY

(With Plates VII, VIII, 1 map and 1 figure in the text)

CONTENTS

## Introduction

In the present article an attempt is made to characterize the most common soil varieties of Palestine by geobotanical data, based on our investigations in this country. True both phytosociological and pedological investigations of Palestine have not as yet reached the stage of a final summarization of results. We are nevertheless in a position today to point out roughly a series of observations on the interrelation of soils and natural vegetation of Palestine.

The edaphical approach to the study of vegetation has proved here as elsewhere of supreme importance in the ecological delimitation of a series of vegetation units. On the other hand, some pedological problems, especially those concerning classification and distribution of minor soil units may be clarified further if vegetation data are brought into consideration.

From the practical point of view it should be stressed that in a country like Palestine, where problems of colonisation, expansion of agriculture and utilisation of non-arable land tracts are most vital, an enumeration of the most important soil varieties in relation to their actual and potential vegetation cover may provide valuable information on certain fundamental agriculture questions.

Many of the pedological records mentioned in this article were quoted from Menchikovsky (1927, 1929, 1938), Puffeles (1936, 1937) Ravikovitch (1941), Ravikovitch and Bidner (1936), Reifenberg (1927, 1928, 1938) etc. Since the work of these pedologists did not embrace all Palestine soils nor consider natural vegetation, we found it necessary to add some original data to our descriptions here. These were obtained by analyses made from soil samples taken in the most typical habitats of plant communities dealt with here. As the stress here is laid on the geobotanical aspect of the subject, pedological data are recorded only to the extent required for a rough ecological description of the soil in question.

Many years of experience in geobotanical work of this country have led us to the conviction that in a country like Palestine, where vegetation is generally subjected to arid and semiarid conditions, the number of soil factors determining the edaphical constitution of the habitat is rather limited. The principal soil factors, which decide upon the character and composition of the vegetation are those conditioning the water relationship of the soil. Next important is the amount of some soluble salts, organic matter, etc. In our analyses we therefore limited ourselves to these factors only. Data on profile development of the soil has not shown itself of great ecological value in our consideration, since the soils of Palestine rarely exhibit profiles with truly genetic horizons as in more temperate regions.

Before approaching the main subject, some notes on the orographical, climatical and phytogeographical relations of the country may be given here in brief.

### (i) *Orography*

A glance at the map of Palestine reveals four longitudinal lines of this country, namely: The Coastal Plain, the Cisjordan Mountain Range, the Jordan Valley and the Transjordan Plateau. Each of these units displays special climatical, biogeographical and to a great extent also pedological pecularities.

The Coastal Plain comprises the light soil belt. Its highest point does not exceed 200 m. above S.L. It is fringed in the West for the most part by the sand dunes which achieve their largest dimensions in the South.

The Mountain Range is transversally interrupted by a few valleys, the most important of which are the Esdraelon Plain, separating the Samaria Mountains from the Mountains of Lower Galilee and the Beersheba Valley, separating the Judean Mountains from the Negeb. These valleys constitute the main lines of connection between the Mediterranean Coast and the Jordan Valley. In the proximity of the main watershed a line may be drawn dividing these mountains into two parts: The western slopes of the mountains are purely Mediterranean in climate and vegetation, while the eastern escarpments are wholly exposed to the effects of the steppe and desert climate. The highest peak of this range is in Upper Galilee (about 1200 m.).

The Jordan Valley is the most striking orographical feature of this country. Its altitude decreases from the North (+150 m. in the Dan Valley) to the South (—392 m. in the env. of the Dead Sea). Climatically and vegetationally it exhibits marked variations according to latitude and altitude.

The Transjordan Belt constitutes a plateau of varying width, interrupted by several latitudinal water courses emptying into the Jordan Valley and the Dead Sea. While its western escarpments are very steep, it slopes gently towards the east, gradually merging into the Syrian Desert. In the upper zone of the western slope, as well as in the adjacent marginal belt of the plateau, the climatical conditions are still more or less Mediterranean, while the eastern part is rather desertic. In the southern part of the plateau the highest point reaches 1650 m. (Edom).

The two longitudinal valleys, the Coastal Plain and the Jordan Valley, constitute the main hydrographical centres of the country. A large series of ephemeral and perennial watercourses springing from the Cis- and Transjordan Mountain Range, empty into the Jordan Valley. Another series of water courses cross the Coastal Plain toward the Mediterranean Sea.

### (ii) *Climate*

Palestine is situated in the subtropical zone and its climate is characterized by the occurrence of two well-marked seasons: the rainy and rather mild winter, being also the main vegetation period and the dry, hot summer. This climate, although uniform in its general hydrothermical features, may for biogeographical reasons be subdivided into three distinct variants: (1) Eu-mediterranean climate with a mild rainy season of 6-7 months and an annual rainfall not below 300 mm., (2) Steppe climate with a shorter winter and with an annual precipitation of about 200-300 mm. (3) Desert climate with a short rainy season and a long, extremely hot and dry summer and precipitations not exceeding 200 mm.

These climatic variants are confined to definite parts of the country, roughly corresponding to the phytogeographical territories dealt with later on. Three hydrothermical figures are recorded below, one of Jerusalem representing Mediterranean climatic conditions, the second of Beersheba representing steppe conditions and the third of Jericho, situated in the desert part.

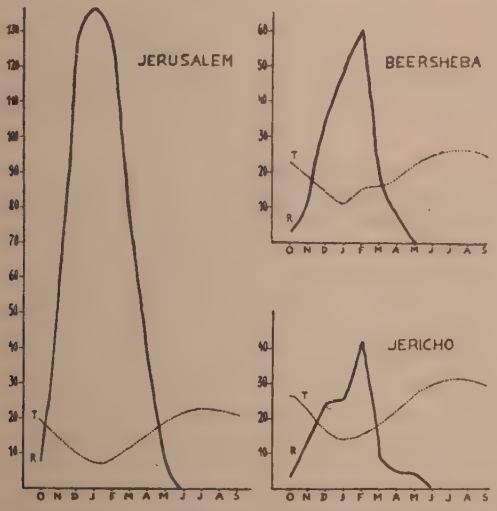



Figure: Hydrothermic curves of Jerusalem, Beersheba and Jericho.
T — mean monthly temperatures in $^0$C.
R — monthly distribution of rainfall in mm.

As seen from the graphs it is principally the rainfall factor which determines the climatic character of each zone. The temperature is less decisive in this regard, especially in the steppe and desert. It is not only the quantity of the precipitation, but the regularity of its appearance which affects plant life. This is

well illustrated by the fact that in the arid parts of the country one often encounters considerable stands of vegetation dead or nearly so. As to the quantity there are considerable tracts of desert, in which the annual amount of rainfall does not exceed 25 mm. The critical moisture limit, beneath which plant life is entirely extinguished, is in our country 75-100 mm. of rainfall. There are of course districts which support vegetation at a much lower rainfall, but here vegetation is confined to depressions, sometimes hardly perceptible, obtaining additional moisture from surrounding parts.

On the other hand a series of phytogeographical facts are known in this arid country for which the thermic factor may be responsible. So for instance the non-advancing of numerous Sudano-Deccanian species towards the northern part of the Jordan Valley, where all ecological conditions, other than temperature, coincide with the requirements of these plants. On the contrary, a series of Syrian plants reach their Southern limit of distribution in the Upper Galilee apparently because of the higher rate of temperature prevailing in more southern latitudes.

### (iii) *Geology*

We mention below the main geological formations which are important with regard to origin and distribution of the Palestine soils.

(1) Of the Lower Cretaceous the so-called Nubian Sandstone layers occupy considerable areas in Edom, and lesser ones in Moab, Gilead and the Negeb. They weather to a sandy soil, comparatively retentive of moisture.

(2) The geological formations of Upper Cretaceous are of supreme importance from the point of view of soil formation in Palestine. They are most abundant both in Cis- and Transjordan. The Cenomanian and the overlying Turonian rock constitute as a whole the parental material of the terra rossa chiefly confined to the Mediterranean territory, but not rarely occurring also in desert and semi-desert parts of the country. Similarly the Santonian hard limestone weather to terra rossa even in desert parts, while the Middle and Upper Senonian rocks are the main source of the grey or white soils so abundant in the steppes and deserts, but not uncommon also in the Mediterranean part of the country.

(3) Of the Tertiary formations the Eocene is the most abundant, principally in Cisjordan. The hard rock of this formation may weather to a more or less typical terra rossa, whereas the more common soft chalks and marls supply bright soils, which are not altogether distinguishable from those of the soft Senonian rock. The post-Eocene Tertiary formations are pedologically only of minor importance.

(4) The Quaternary period is of utmost importance in regard to soil formation and distribution. Large stretches of the Jordan Valley owe their soil to the marly fine-layered deposition of a Diluvial brackish sea — the so called Lissan Marls. Since this period the accumulation of the sand dunes, covering immense tracts in the Coastal Plain and in the adjacent deserts have taken place. The formation of the kurkar hills and the red sand of the Coastal Plain as well as that of the loess cover of the Negeb and the hammadas of the desert are similarly confined to the Quaternary. But the most important pedological feature of this period is the filling up of the plains and valleys with a loamy soil, transported from the adjacent mountains through soil erosion.

(5) Apart from sedimentary and eolic formations a few soil varieties owe their existence to igneous rocks. Of these the basalt rocks occupy considerable areas of the Lower Galilee, the Upper Jordan Valley, the NE. Part of the Esdraelon Plain and the Northern Transjordan. The weathering product of it is a brown heavy soil, poor in calcium carbonate when in the oropedic stage. Less important are the igneous rocks of Southern Transjordan, appearing as granits, gneiss, porphyres etc. and weathering to a poor sandy soil.

### (iv) *Phytogeographical relations of Palestine*

It is impossible here to do more than touch upon the main feature of this subject. Due to its geographical situation, Palestine constitutes a meeting-ground for three large phytogeographical regions, viz: the Mediterranean, the Irano-Turanian and the Saharo-Sindian. The contiguous boundaries of these regions divide Palestine into three phytogeographical territories, each characterized by special ecological conditions, special flora and vegetation. Apart from the floristic elements of these three regions, Palestine also harbours plants of other regions, which do not occupy particular territorial units here such as plants of the Sudano-Deccanian and the Eurosibero-Boreoamerican elements. Palestine may thus be subdivided into a Mediterranean territory, an Irano-Turanian, and a Saharo-Sindian (see the accompanying map.). The first who recognized and determined these territories was Eig (1931, 1938).

Besides the monoregional plant groups of the five above-mentioned phytogeographical elements, there is a series of bi-, tri- and poly-regional plant groups. These groups of connection, though constituting a high proportion of the total flora of the country, by no means obscure the phytogeographical character of the mentioned territories.

The Mediterranean territory is the district of arboreal climax communities. Four main groups of forest and maquis communities are represented here: the *Pinus halepensis* forest, the Tabor oak forest and forests or maquis of *Quercus calliprinos* and of *Ceratonia Siliqua-Pistacia Lentiscus*. Due to the vicinity of the desert as well as to certain historical and ethnical circumstances the Palestine wood flora was more than elsewhere in the Mediterranean subject to heavy destruction, so that today the so-called batha (EIG 1927) a kind of dwarf shrub formation, occupies the greatest part of the mountain slopes still uninvaded by cultures.

The Irano-Turanian territory constitutes a steppe country, deprived of arboreal climax communities, except in its northeastern part, where *Pistacietum atlanticae* and *Zizyphetum Loti* occur. Agriculture is mostly unstable here due to irregularity and scantness of annual precipitation; it is however of agricultural importance in the Negeb and in Transjordan especially in the loess and sand loess region. The vegetation consists of a rather large number of plant communities, composed of herbs and dwarf shrubs.

The Saharo-Sindian territory is the most barren part of the country. No arboreal vegetation is encountered except in oases and near water courses. The vegetation cover is generally very thin, and there are also considerable stretches almost completely devoid of vegetation. Salt lands, sandy dunes and dreary hammadas are most characteristic of this territory.

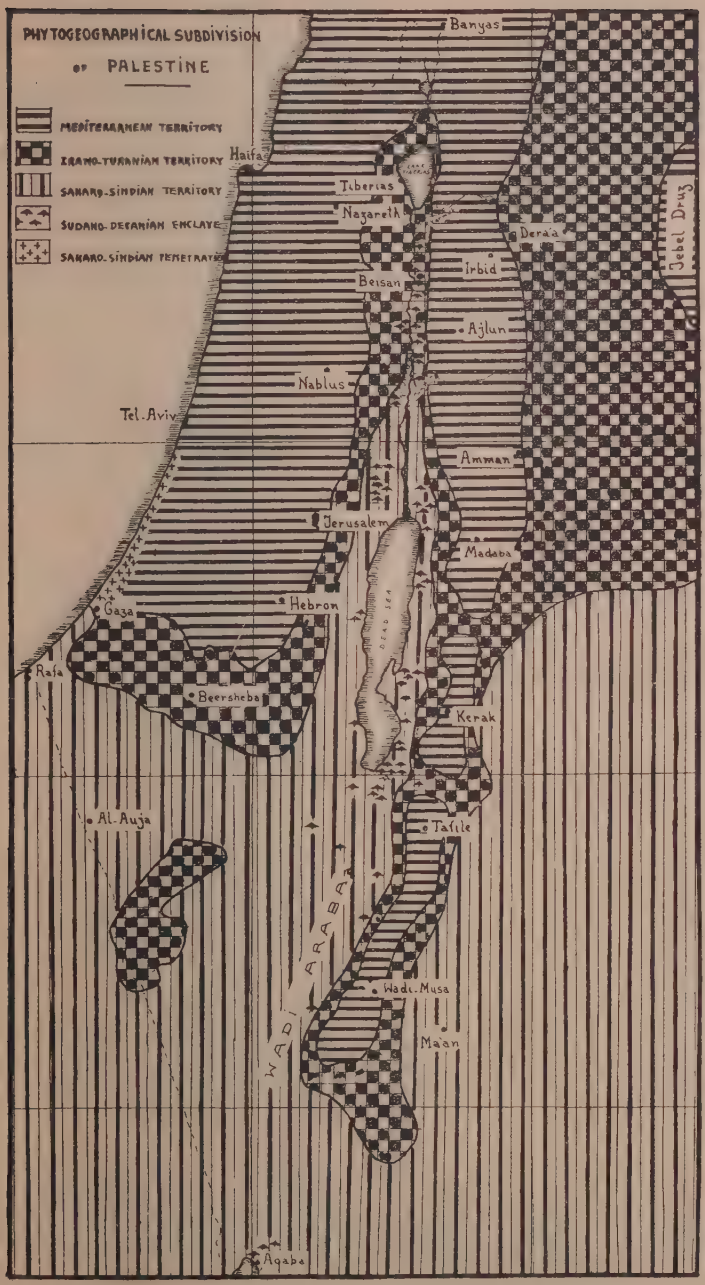
### (v) *Some remarks on Palestine soils*

#### (1) *Soil development*

Mature soils, such as are characteristic for northern latitudes, are only of rare occurrence in Palestine. There are a series of obstacles disturbing the progressive course of soil development, among them: the strong relief of the country, the devastation of natural vegetation by man, and the climatic influence of the desert.

Vigorous action of erosion, caused by topography, leads to a continuous removal of the soil of the upper horizons from the hill and mountain region and its accumulation in the lowland. Immense masses of soil are thus transported both to the vicinity of the Coastal Plain and into the Jordan Valley, so that in both regions the soil profile is perpetually rejuvenated. Agriculture of the arable plains, careless destruction of previous vegetation and the torrential character of the rainfall are additional factors in suppressing profil development.

In the desert parts of the country the soils are kept in early stages of development due to the predominance of physical weathering. Even in deserts of fairly smooth topography soil development is strongly disturbed by the action of the wind causing


PHYTOGEOGRAPHICAL SUBDIVISION
OF PALESTINE
MEDITERRANEAN TERRITORY
IRANO-TURANIAN TERRITORY
SAHARO-SINDIAN TERRITORY
SUDANO-DECANIAN ENCLAVE
SAHARO-SINDIAN PENETRATION
Banyas
Haifa
Tiberias
Nazareth
Derâa
Jebel Druz
Irbid
Beisan
Ajlun
Nablus
Tel-Aviv
Amman
Jerusalem
Madaba
Hebron
Gaza
Rafa
Beersheba
Kerak
Al-Auja
Tafile
WADI ARABA
Wadi-Musa
Maan
Aqabe

deflations on one hand (e.g. hammada) and continual eolic sedimentation on the other (e.g. loess and sands).

From the pedogenetical point of view the automorphic soils of Palestine may be subdivided into the following categories :

Mountain soils with truncated profile, strongly skeletal and often rocky.

Colluvial soil of the great agricultural plains and valleys, in which the profile has been considerably modified through continuous redeposition and human interference.

Sand dunes in varying stages of fixation, sand fields and sandy loams.

Steppe and desert soils e.g. loess, loess-like soils, hammadas and other desert soil varieties.

The hydromorphic soils (alluvial and saline) constitute a series of minor units well distinguished in their vegetation.

The reaction of all the Palestine soils hitherto analysed is alcaline and only seldom neutral or very slightly acid. Humus bearing horizons are rare.

(2) *Soil distribution*

On broad lines we may characterize the geographical distribution of the Palestine main soil types as following :

The Mediterranean territory is the main district of the terra rossa, of the grey-brown loams, the basalt soils and the light soils of the Coastal Plain.

The Irano-Turanian territory is the main seat of the grey steppe soils, the loess as well as of a part of the basalt soil.

The Saharo-Sindian territory is the district of the hammada soils, sand dunes, and saline soils.

But there appear considerable deviations in this climatical phytogeographical arrangement of the soils. So for instance terra rossa also occurs in the Irano-Turanian and even in the Saharo-Sindian territory ; sand dunes and their derivatives (kurkar and red sand) occur in areas of typical Mediterranean conditions ; basalt soils mainly confined to the Mediterranean territory reoccur in arid zones of the country, and so on.

These and a series of other facts mentioned below clearly show that, without minimizing the part played by climate upon the genesis of the soil, the lithological character of the parent material remains still very significant in determining the nature of Palestine soil.

(3) *Soil classification*

Although the relations between the soil type character and climatical conditions are so intimate as to be reflected in the existence of a belted distribution of soils in certain continents, soil classification of individual countries and single geographical regions can hardly be based on climatic conditions alone. More-

over, in countries like Palestine, for which, as has been shown above, immature stages of soil development are most characteristic, a soil classification based on climatic consideration is rather misleading. A few instances may be mentioned here in this regard : terra rossa is associated in Palestine with hard limestone of the Upper Cretaceous and Tertiary, while white soils are produced from soft chalks and marls of the same formations, whatever the climatic conditions may be. Red sandy clays are derived from the older dunes, and basalt rocks, although appearing side by side with hard limestone rocks, never produce true terra rossa. Similarly, the igneous rock of southern Transjordan weathers into a soil pedologically different from that of the Nubian Sandstone of the same region.

(4) *Geobotanical aspect of soils*

It is not the aim of this paper to supply full information on the pedological character of the Palestine soils. This has to be done by pedologists and a good deal of this work has already been done by them.

In the present article an attempt is made to reveal the existing interrelations between the different soil varieties and their vegetation. The soil is thus considered here as the edaphical factor of the habitat and not as a pure pedological subject. Consequently attention is devoted only to those traits of soil character which decide upon the ecological constitution of the habitat and which have a selective effect upon the differentiation in vegetation. The number of such soil characteristics is rather small. Among them we may mention the quantity of soluble salts and those mechanical and chemical properties of the soil determining the moisture conditions of the soil as most important.

The term soil is used in this paper in a broad sense including also unconsolidated geological strata and sometimes even rocky ground as far as this supports vegetation.

Finally it may be stressed here that the soil varieties dealt with here are not always definite typological and pedological units, but rather ecological. That is to say that the nature of the plant communities characterizing these soil units may not always be determined by the edaphic conditions alone, they may also be caused by certain other ecological conditions, such as climate, topography etc., coupled and acting together with the edaphic factor of the habitat.

## Soil varieties and their vegetational characterization

The following groups of soils are treated here in connection with their vegetation cover. (i) Calcareous soils ; (ii) Basalt soils ; (iii) Sandy and sandy-calcareous soils ; (iv) Loess soils ; (v) Alluvial soils ; (vi) Saline soils.

### (i) *Calcareous soils*

(1) *Terra rossa*

This soil type is most abundant within and most characteristic for the Mediterranean territory of Palestine. It is commonly believed that in Mediterranean conditions the calcareous rock, whatever its petrographical constitution may be, weathers to terra rossa. But observations in Palestine make it obvious that it is mainly the hard limestone of the Cenomanian and Turonian, as well as that of Santonian and Upper Eocene formations which weathers here into terra rossa. The humus content of terra rossa is generally low, and its reaction is always alkaline. The proportion between the content of sesquioxydes, Ca, $SiO_2$ in the parental rock and that found in the superficial red soil is given in the following figures reported by REIFENBERG (1938) for a Cenomanian rock and soil in Samaria.

| | $Al_2O_3$ | $Fe_2O_3$ | $SiO_2$ | CaO | $CO_2$ |
|---|---|---|---|---|---|
| rock | 0,90 | 1,50 | 0,29 | 54,22 | 42,60 |
| superf. soil | 12,29 | 7,85 | 51,07 | 6,60 | 4,12 |

According to MENCHIKOVSKY (1938) the amounts of sesquioxydes do not vary with the depth, while the amounts of colloidal clay increase markedly with the depth of the profile.

In the following we report some figures obtained by us from a typical terra rossa covered by a *Poterietum spinosi* in the environs of Jerusalem :[1]

| depth in cm. | 15 | 40 | depth in cm. | 15 | 40 |
|---|---|---|---|---|---|
| $H_2O$ % ($105^0$) | 5,1 | 5,5 | water soluble salts | 0,0640 | 0,118 |
| $CaCO_3$ | 23,9 | 37,9 | Cl | 0,0145 | 0,0044 |
| clay | 10,0 | 2,5 | $HCO_3$ | 0,0353 | 0,0443 |
| silt | 11,2 | 27,5 | pH | 7,3 | 7,5 |
| fine sand | 49,3 | 25,7 | | | |
| coarse sand | 0,5 | 0,9 | | | |

For further information on the physicochemical properties of this soil the reader may be referred to REIFENBERG (1927, 1938), who studied this soil in detail.

Terra rossa occurs in Palestine as elsewhere in the Mediterranean in two main facies : the oropedic and the transported, mostly redeposited, facies of the plains.

(a) *The oropedic facies* constitutes mostly a shallow soil cover and very seldom exhibits a developed profile. The A horizon, generally reaching a depth of 10-60 cm., overlies mostly the rocky-skeletal C horizon. Very often considerable areas in the mountains are destitute of any continuous soil cover and only more or less deep pockets of soil are hidden in the cavities of the rock. In some parts of the mountain region the surface consists of projecting dolomitic bare rocks, and the soil accumulates only

[1] The analytical figures recorded in this paper refer to percentage of dry matter. $CaCO_3$ is calculated from $CO_2$.

in the interspaces. Besides these immature or ruinous occurrences, there are considerable areas of the oropedic stage, in which the soil is conserved by terrace culture.

In connection with this facies of terra rossa we should mention a series of developmental stages of the vegetation cover. The Mediterranean mountain region of Palestine constitutes an area the climatical climax of which is made up mainly of arboreal associations such as the association of *Quercus calliprinos — Pistacia palaestina* and that of *Ceratonia Siliqua — Pistacia Lentiscus,* etc.

Since deforestation began — and this may be dated here from the earliest days of history — the soil cover of this mountain region has been subjected to gravest action of erosion, added to by the steepness of the slope and torrential character of the rainfall. Immense masses of the mountain terra rossa were transported to the plains and valleys so that in a great part of the mountain slopes very shallow soil layers, skeleton soil and the naked rock in various stages of desintegration came into appearance.

Yet forest and maqui trees may establish themselves on this ruinous soil, but it is human interference which does not allow natural restoration of the woody plant communities. A series of heliophytic, non-arboreal plant associations therefore occupy a large part of these soils in Palestine.

In the following we wish to mention the common plant associations of the oropedic terra rossa. Some of them may be considered as developmental stages of the Lithosere of the Mediterranean mountain region of Palestine.

(1) The rocky stage. The first to occupy the naked rock surface is a series of crustaceous lichen associations which in the course of time give rise to slight excavations and small pit-shaped hollows in the rock surface, subsequently filled up by small quantities of dust and soil.

(2) At this stage a series of lithophytic and chasmophytic plant communities of the *Varthemion iphionoides,* such as *Varthemia iphionoides — Stachys palaestina* association and its varieties, *Podonosmetum syriacae* etc. extremely poor in species, inhabit the rock. The roots of the leading species of these association seem to be very active in the further disintegration of the rock and may contribute, after a series of intermediate stages, to the formation of boulders and coarse pebble, the spaces between which are filled with fine red soil (Plate VII A).

(3) This and further phases of the skeleton stage are characterized by a series of plant associations mostly fragmentary in composition, such as *Fibigia clypeata — Althaea setosa, Cynocrambetum prostratae* and others.

(4) On stony slopes, or on terraces, where only a shallow soil-cover overlies the rock, *Thymetum capitati, Fumanetum glu-*

*tinosae, Cistetum villosae* etc. are the most characteristic plant communities.

(5) As soon as the soil-cover advances towards a more or less developed profile, another series of dwarf shrubs and garigue associations inhabit the slope. Of these *Poterietum spinosi, Calycotometum villosae* etc. are most characteristic of this habitat. At this stage and no doubt also in earlier stages of development, the soil is apt to maintain some advanced links of the successional sere, approaching the climax association. Usually, however, the soils of this stage are taken as soon as they appear under cultivation, if not subjected again to erosion through devastation of the higher vegetation by man.

These developmental stages appear not only as progressive successional links of the sere but also as a result of degradation processes, and so a variegated mosaic of developmental stages, both of soil and vegetation, is the most characteristic feature of the oropedic red soil.

In the agropedic facies of the oropedic terra rossa some secondary plant communities are most common and characteristic, namely the association of *Ononis leiosperma — Carthamus tenuis,* that of *Ononis leiosperma — Phlomis orientalis,* of *Ononis leiosperma — Phlomis pungens* etc., occurring as segetal associations of non irrigated crops and indicating a somewhat deeper soil of the mountainous region.

(b) *The transported terra rossa.* This soil variety occupies large tracts of the great plains. While in its chemical constitution, this soil seems to be more or less uniform over great areas and over the whole profile, its mechanical composition varies with the depth and according to surface relief. Approaching the centre of the valley the clay fraction increases and the colour turns brownish to grey. In extreme cases it is sometimes difficult to distinguish between it and some kinds of alluvial soil. It is a more or less heavy loam of a considerable depth, mostly exhibiting a higher capacity for moisture retention, but often also unbadly aerated. The profile does not exhibit sharply distinguishable horizons, as it has been an agropedic soil since ancient time. An example of this soil in the Shefela (Kubab—Ramleh district) in a *Prosopis farcata — Scolymus maculatus* association shows the following composition:

| depth in cm. | 10-20 | 20-30 | depth in cm. | 10-20 | 20-30 |
|---|---|---|---|---|---|
| $H_2O\%$ ($105^0$) | 8,9 | 9,4 | water soluble salts | 0,080 | 0,069 |
| $CaCO_3$ | 9,0 | 10,0 | Cl | — | — |
| clay | 17,5 | — | $CO_2$ | 3,96 | 4,4 |
| silt | 26,2 | — | pH | 7,2 | 7,1 |
| fine sand | 38,3 | — | | | |
| coarse sand | 0,1 | — | | | |

As to the natural vegetation designating these soils, it may be noted that due to the fact that these areas were put under cultivation very early in history, the primary vegetation has had time enough to be completely destroyed. The only natural vegetation in these areas is of secondary origin, consisting of segetal associations. Of these we may mention the *Prosopis farcata — Scolymus maculatus* representing the most common association. It exhibits two distinct seasonal aspects: the Winter aspect with numerous herbaceous species, while *Prosopis* is the leading species of the Summer aspect.

With regard to the climax association of this soil there is a good deal of evidence that various forest communities, especially *Quercetum ithaburensis,* and probably also the *Ceratonia Siliqua — Pistacia Lentiscus* association once covered the greater part of these areas (within the Mediterranean territory). The occurrence of stands or scattered trees of the Sudano-Deccanian *Zizyphus Spina Christi* in the heart of these plains can by no means obscure the eu-Mediterranean nature of these areas, since *Zizyphus Spina Christi* must be considered as one of the youngest invaders of the Mediterranean plains of Palestine. Its penetration into these areas is due to the complete devastation of the primary Mediterranean vegetation by man. As a matter of fact *Zizyphus Spina Christi* occurs not only in the Mediterranean soils but also in other deep-soiled non-saline plains, valleys with optimal moisture conditions.

This soil is agriculturally the most fertile, being suited to Winter and Summer crops as well as to horticulture.

In the Southern Shefela a wide belt of transported soil is intercalated between the light soil belt and the eastern foot hills. Reifenberg (1938) called this soil which extends over a large area between Rehovot and Gaza "Mediterranean steppe soil". Range (1922) considered this soil a mixture of three components i.e.: (a) the weathering product of kurkar hills, (b) loess soil imblowed from the South, (c) the transported red and grey soil from the Tertiar and Cretaceous hills in the East.

From our own investigations (Feinbrun and Zohary 1942) in the above-mentioned area we hold that the soil in question is a heavy deep soil, transported mainly from adjacent mountains and redeposited here on and between kurkar hills. It is locally termed "Salagha" and is considered a fertile agricultural soil. Both in its mechanical and chemical composition and in its vegetational aspect it represents a rather typical Mediterranean soil, similar to that of other plains of more northerly districts. There is thus no reason to consider this soil a special unit as held by Reifenberg.

The extremely poor and unreliable remnants of the primary vegetation do not allow of any conclusions concerning the climatic climax of this area. It is, however, obvious from the climate,

soils, agriculture and human history that the previous vegetation of this area was a kind of Mediterranean maquis, although not a single Mediterranean tree may at present be found in the whole district. It is the fertility of the soil, the favourable climatic and topographical conditions and other attractive features which gave rise to the establishment of agriculture of this "Interior Philistaea" at a very early date of human history; hence the complete devastation and obliteration of the local arboreal vegetation.

The only trees met with here are *Tamarix articulata, Zizyphus Spina Christi* and *Ficus Sycomorus,* the latter doubtfully spontaneous. But these Saharo-Sindian and Sudano-Deccanian trees, characteristic as they appear for the landscape, are only comparatively late immigrants into this district and their penetration was made possible only by the removal of the primary vegetation.

Of the natural non-arboreal vegetation characteristic of this soil, two plant communities may be mentioned: (1) the *Poterium spinosum — Thymelaea hirsuta* association, occupying at present mainly the non-arable hills, and constituting the sub-climax vegetation of this area, (2) some segetal associations of the *Prosopion farcatae* extending over the vast undulating plains, extensively cultivated for wheat and barley.

In addition to its Mediterranean distribution, terra rossa has also been observed in the Mediterrano—Irano-Turanian transition zone as well as in the Irano-Turanian territory e.g. in the Judean Desert in the Negeb and Transjordan. In all these districts it is confined to the hard limestone of the Upper Cretaceous. The vegetation characterizing these rocky habitats consists of *Phlomidetum brachyodontis* (Judean Desert) and the association of *Retama Roetam* (slopes facing the Jordan Valley) etc. There are large areas of transported terra rossa in the Jordan Valley the fertility of which however depends upon the occurrence of ground water sources.

Dealing with the rendzina soil of Spain and Algeria, DEL VILLAR (1937) states that this soil constitutes a humous carbonate soil closely related to terra rossa but differring from it by the high content of humus in the A horizon. The same opinion is expressed by NEVROS and ZVORYKIN (1939), dealing with the rendzina soils of Crete. According to these authors terra rossa may be considered as a derivation of rendzina deprived of its humus-containing A horizon.

In Palestine I observed a kind of rendzina in two localities, viz: in Upper Galilee and in Samaria. In both places it occupies mountain slopes exposed to the North and West, covered with dense Mediterranean maqui vegetation. The profile shows a well-developed surface layer of black humus overlying a brown clay. We had not yet opportunity to study this soil more in detail, but it is clear that in Palestine this soil is restricted to the terra rossa district and is limited only to mesophytic habitats less affected by deforestation and erosion. Its isle-like occurrence within the area of terra rossa may support the opinion that a good proportion of the present Mediterranean terra rossa is derived from such rendzina soil.

The vegetation characterizing this soil is a mesophytic variety of the *Quercus calliprinos — Pistacia palaestina* association designated by the oc-

currence of *Laurus nobilis, Cercis Siliquastrum* and sometimes of *Quercus infectoria* and *Acer syriaca,* as well as of some mesophytic ferns and lianes. The degree of covering reaches often 100% here.

(2) *White and grey soils*

Under this heading we tentatively group those white or grey soil varieties which occupy vast stretches both in the Mediterranean and the desert parts of the country. They are extremely rich in calcium carbonate (up to 85%), increasing with the depth, extremely poor or altogether devoid of humus. They possess a high air content and very low water-retaining capacity. The amount of sesquioxydes, according to MENCHIKOVSKY (1938) is very low in comparison to that of terra rossa and the amount of soluble salts seldom reaches an average of 0,1%. These soils originate principally from soft chalks and marls of the Cretaceous and Tertiary formations, as well as from the so called lissan marls of the Diluvium, sometimes also from the "nari" cover of various geological formations.

It is astonishing that these soils which occupy a large part of the Palestine surface and differ strikingly from terra rossa in constitution and ecological properties were hitherto treated so inadequately by Palestine pedologists.

For the time being we may subdivide these soils into minor units according to their ecological character and agricultural value.

(a) *Mediterranean whitish soils*

In the midst of the Mediterranean territory of terra rossa one encounters both in Cis- and Transjordan large areas and minor enclaves of soft calcareous rocks weathering into a whitish soil. Sometimes, however, in wadis and lowland transitions in colour between terra rossa and this soil are encountered. Of the main districts in which this soil occurs the following may be mentioned: Upper Galilee (env. of Hanita and Safed), Lower Galilee (e.g. Nazareth district), Samaria (e.g. env. of Bath Shlomo and Nablus-Jenin), Judea (e.g. Bab el Wad, Hartouv), etc. In spite of the eu-Mediterranean conditions prevailing in these localities no formation of terra rossa occurs as the parental rock alone decides the soil character.

Some analytical figures obtained from a soil sample taken in the vicinity of Nablus (at km. 71 on the Jerusalem—Nablus road) may be quoted here:

Depth 10-20 cm.; colour white; clay 16,2%; silt 35,0%; fine sand 24,3%; coarse sand 24,5%; water soluble salts 0,201%; Cl 0,0092%; $HCO_3$ 0,0694%; $CACO_3$ 57,5%.

Vegetationally this soil is well distinguished from terra rossa by the following: (1) In rather low altitudes, as for instance the N.W. part of Samaria and some districts of Lower Galilee, *Quercetum ithaburensis* is the only arboreal climax association confined to this soil. (2) In Upper Galilee, Samaria, the Judean

Mountains and Ajlun it is this white or whitish soil to which *Pinetum halepensis* is generally confined. As elsewhere in Mediterranean countries this forest type does not require special edaphical conditions for its development and is thus able to establish itself here on soils less favourable for the *Quercus calliprinos — Pistacia palaestina* association. (3) The regeneration of the arboreal Mediterranean association seems to be impeded on this soil, and there where only batha formation occurs it contains a series of Irano-Turanian or Mediterrano—Irano-Turanian species like *Ononis Natrix, Alkanna strigosa, Echium Blancheana, Anchusa strigosa, Heliotropium rotundifolium* etc. (Plate VII B).

From the agricultural point of view this soil is designated by its lower fertility. It is less suitable for maintaining summer crops, and even fruit trees suffer here from the excess of lime. Since its capacity for retaining moisture is very low, it dries too soon, especially in years of scantier rainfall.

(b) *White and grey steppe soils*

In the Irano-Turanian territory white, greyish and grey soils are rather common. They originate from soft chalks and marls. In their chemical composition they seem to be identical with the Mediterranean aforementioned white soils. They generally differ from the latter however by some minor characteristics e.g. texture, water content, complete lack of humus etc. The soil is often immature with no differentiated profiles. The term steppe soil adopted here is only tentative and local since the relation of this soil to the zonal grey soils is not yet clear to us.

From an analysis of this soil taken in the Judean Desert (13 km. E of Jerusalem 200 m. *Artemisietum Herbae albae*) we obtained the following figures :

| depth in cm. | 10-20 | depth in cm. | 10-20 |
|---|---|---|---|
| $H_2O$ % (105°) | 3,8 | water souble salts | 0,050 |
| $CaCO_3$ | 64,6 | Cl | 0,003 |
| clay | 7,5 | $CO_2$ | 27,2 |
| silt | — | pH | 7,75 |
| fine sand | 24,1 | | |
| coarse sand | — | | |

Other samples taken from similar places differ markedly in the amount of calcium and in the mechanical composition, but very slightly in the amount of soluble salts.

From the vegetational point of view this soil is designated by a series of true Irano-Turanian non-arboreal plant associations such as *Artemisietum Herbae albae,* widely distributed both in Cisjordan and especially in Transjordan *Noeetum mucronatae, Ononidetum Natricis* etc. Each of these plant associations is confined to a particular habitat, apparently determined by microclimatic and microedaphic conditions which are not adequately

known to us. Here more than in other parts of Palestine exposure and relief factors determining the water relations of the soil play a supreme ecological role. In general these plant communities exhibit a high degree of covering in comparison to those of the desert soils mentioned below.

Agriculturally these soils have little value, since on the one hand they are limited to an area in which the amount of annual precipitations is rather low, and on the other, these soil areas are deprived entirely of permanent water courses or any other water sources which could support irrigation. There are however large tracts in Transjordan previously covered by *Artemisietum Herbae albae* in which field crops are extensively cultivated.

(c) *Desert soils (non-saline)*

Under this category we tentatively include a series of soil units of unequal typological value, generally confined to Saharo-Sindian territory of Palestine and originating from Upper Senonian rocks, some of them of Quaternary calcareous gypseous deposits. They are extremely calcareous, and often contain large amounts of sulphates also. Most of them are non-saline. They exhibit skeleton texture mostly and are extremely dry. They are all inadequately investigated from the physico-chemical standpoint, but are much better known from the vegetational aspect. Of the several units belonging to this series we mention here only a few.

(1) *Gypseous soils.* As an example of this soil which is widely distributed in the eastern mountainous part of the Judean Desert we mention that derived from Middle and Upper Senonian layers. It is white or grey, compact, but mealy with no differentiation of horizons and often hardly distinguished from the underlying rock. The following figures were obtained from a sample taken in the vicinity of the Jerusalem—Jericho road at km. 21,3 E of Jerusalem. The amount of annual precipitation does not exceed 200 mm. here (Ashbel 1928).

| depth in cm. | 15 | 40 | depth in cm. | 15 | 40 |
|---|---|---|---|---|---|
| $H_2O$ % (105°) | 16,1 | 15,8 | water soluble salts | 0,930 | 0,986 |
| $CaCO_3$ | 18,7 | 9,9 | Cl | 0,0284 | 0,0090 |
| clay | 3,75 | 5,0 | $HCO_3$ | 0,0268 | 0,0247 |
| silt | 8,75 | 13,75 | pH | 7,3 | 7,15 |
| fine sand | 40,2 | 47,7 | | | |
| coarse sand | 12,5 | 7,8 | | | |

The natural vegetation of this soil is the *Chenoleetum arabicae* (Eig 1938), an almost endemic association, exhibiting a low degree of covering.

A somewhat different constitution exhibits that soil which is extensively covered by the *Suaedetum asphalticae* in the hilly area of the eastern part of the Judean Desert (Plate VII C).

Here are the figures obtained from an analysis of this soil at km. 23 E of Jerusalem :

| depth in cm. | 10-20 | 20-30 | 30-40 |
|---|---|---|---|
| water soluble salts | 0,280 | 0,450 | 0,805 |
| Cl | 0,006 | 0,154 | 0,253 |
| $CaCO_3$ | 77,0 | 74,2 | 75,0 |
| pH | 7,4 | 7,4 | 7,4 |

Other samples of the same soil exhibit a lower amount of carbonates, while their sulphate content is exceedingly high.

Concerning desert soils mention must be made also of the Eocene and Senonian rocky hills, on which a grey immature soil accumulates between stones and boulders. The typical association confined to these habitats are *Zygophylletum dumosi, Gymnocarpetum fruticosi* etc.

(2) *Hammadas.* The most characteristic soils of the Palestine deserts, both in Cis- and Transjordan, are represented by the hammadas. These are wide, open, somewhat undulating plains more or less densely covered with stones, pebbles, and gravel (mostly small angular flint pieces). The underlying soil is often fine, dusty, loose or compact, white or grey and mixed with pebbles. The hammada plains are frequently cut by shallow, broad, gravelly or sandy wadis. Though more or less uniform in appearance, the hammada soil doubtless constitutes a series of varieties in their physico-chemical constitution. In general the soil of the hammada does not contain salts in an amount injurious to non-halophytic plants, but occasionally the salt content (chlorides) increases considerably (Plate III C — p. 96, Vol. II, No. 1).

The hammada represents the most desolate habitat of the desert. Frequently large tracts of it are devoid of vegetation. In less extreme hammadas the degree of covering rarely exceeds 10% of the surface. Only in depressions does a denser vegetation occur. The wadis crossing these plains are always more or less densely inhabited by vegetation. These are the main harbours of desert flora.

Here are some figures obtained from an analysis of a more or less typical hammada soil in the vast plains of Transjordan (about 110 km. S of Amman), dominated by an *Anabasidetum articulatae* :

---

EXPLANATION OF PLATE VII

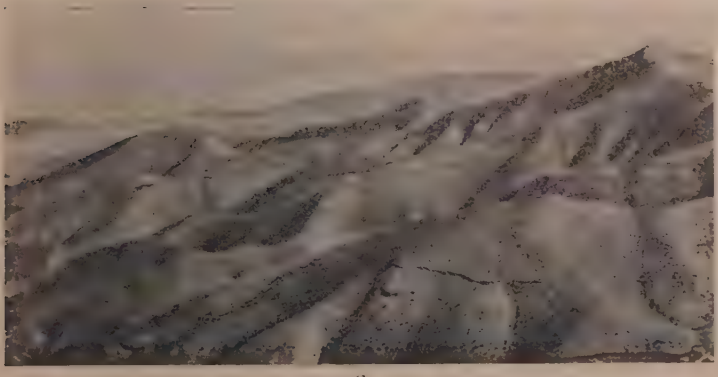
A : Association of *Varthemia iphionoides* — *Stachys palaestina* on hard limestone rocks at Tayibeh (Samaria).

B : *Quercetum ithaburensis* on whitish Eocene soil at Sheikh Ibrik (Lower Galilee).

C : *Suaedetum asphalticae* on soft Senonian gypseous soil. Judean Desert.

A

B



C

ZOHARY — VEGETATIONAL ASPECT OF PALESTINE SOILS

| depth in cm. | 0-10 | 10-20 | 20-30 | depth in cm. | 0-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| $H_2O\%$ (105°) | 4,0 | 4,1 | 4,2 | water soluble salts | 0,125 | 0,122 | 0,125 |
| $CaCO_3$ | 31,7 | 25,5 | 29,6 | Cl | 0,002 | 0,006 | 0,006 |
| clay | 25,0 | 15,0 | 8,7 | pH | 7,7 | 8,3 | 8,5 |
| silt | 5,0 | 15,0 | 25,0 | | | | |
| fine sand | 29,6 | 39,9 | 32,4 | | | | |
| coarse sand | 4,7 | 0,5 | 0,1 | | | | |

The most characteristic plant association of the hammadas, both in the Far Negeb and in Transjordan, as well as in the Sinai Peninsula, is the *Anabasidetum articulatae*, sometimes reduced only to its single leading component.

(3) *Lissan marl soils.* Under the name "Marnes de Liçan", LARTET described the calcareous, delicately stratified marls, containing great amounts of gypsum. These marls extend over almost the whole Jordan Valley and represent a sediment of a vast brackish Diluvial inland sea (PICARD 1938). At present this lissan marl terrace of the Jordan Valley represents an area of a mixed pedological character due to the great pedogenetical changes this plain has undergone during Alluvium and Recent, and due to hydrographical differences between the various parts of the Jordan Valley.

Dealing with the soils of this region one must clearly distinguish between its northern and its southern parts. While in the Upper Jordan Valley the lissan marl region constitutes a more or less fertile land of irrigation cultures, the southern part is exceptionally suited to cultivation. Each of these two districts displays a series of soil varieties, readily distinguishable both pedologically and vegetationally.

(a) In the Upper Jordan Valley the soil contains in general large amounts of $CaCO_3$ increasing with the depth, and a low amount of soluble salts. The largest part of this area previously represent a solontchak soil, was leached out in the course of time by the greater annual precipitation (250—300 mm.) of this area (MENCHIKOVSKY 1938).

In the Beisan Plain, for instance, three terraces are distinguishable in the lissan marl region. The lowest, the so-called ez-Zor, represents a belt of alluvial soil bordering the Jordan River. The middle terrace the "Jordanhochterrasse" of PICARD (1932) is covered by a chalky soil transported from a higher terrace and intermingled with the local lissan marl soil. It is a mealy grey or white soil exceedingly rich in $CaCO_3$ and inclining to salinization in places of a high ground water table. This soil is now under cultivation by irrigation. On the third and highest terrace of this plain the lissan marl is thickly covered by a younger layer of sinter, and its weathering product is a soft mealy chalky soil. This soil is poorer in water courses than that of the middle ter-

race and its groundwater table is markedly lower; therefore no saline patches occur here.

The natural vegetation is represented in these soils (Upper Jordan Valley and Beisan Valley) by two main associations, no doubt of secondary origin, viz.: *Zizyphus Spina Christi—Zizyphus Lotus* and *Prosopis farcata—Carthamus glaucus*, the latter being only a degradated stage of the former. Both associations are here true indicators of deep and wellwatered soils. The primary vegetation of this region is doubtless a kind of *Zizyphetum Loti*, belonging to the Irano-Turanian element. This association has to be considered as the climatic climax association, both of the Beisan Plain and of the Upper Jordan Valley. *Zizyphus Spina Christi* probably existed here in preanthropous periods, but was closely confined to the vicinity of the water courses.

(b) In the Lower Jordan Valley large tracts of the lissan marl belt are covered by a solontchak soil. The lissan marl soil is only partly exposed on the surface. A good part of it is covered by transported white-greyish (Senonian) desert soil interrupted here and there by patches of red, yellowish and brown (Cenomanian) soils, similarly transported from the mountains. Part of these darker soils arrived by means of greater water courses which form at their broad outlets a series of oases. They will be treated in a later chapter. Another part of the transported dull-brown soil, mainly at the outer borders of the Valley, is comparatively poor in soluble salts and supports a semi-halophytic vegetation over wide stretches, such as the association of *Salsola villosa—Stipa tortilis*. The depth of these transported soil layers gradually decreases towards the Jordan River, so that the lissan marl or its weathering products appears at the surface only at a considerable distance from the mountains. The soil layer deriving from lissan marl layers and overlying them is rather thin. It contains large amounts of gypsum, lime and soluble salts.

A dense net of wadis transformed the interior part of the lissan marl plain into the so-called "Broken Land". In the lower parts and in the wadis and terraces of this "Broken Land" the soil is extremely rich in soluble salts and characterized by a special halophytic vegetation which will be dealt with below.

### (ii) *Basalt soils*

A considerable proportion of Palestine soils owes its origin to eruptive basalt rocks, mainly consisting of plagioclase, porphyr, diorite etc. (Picard 1929). These soils are confined to a special area comprising the south-eastern part of the Lower Galilee, the northern part of the Upper Jordan Valley, the eastern escarpments of Upper Galilee Mountains, parts of the Dan Valley, the Hauran etc. As in the soils formed from sedimentary rocks, two main facies have to be distinguished here: (1) soil of the oropedic stage, (2) transported and redeposited soil of the

plains and valleys. The most common variety of these soils is however a basalt loam intermixed with terra rossa accumulated in the valleys, bordering the calcareous mountains on the one hand and basalt on the other. In the oropedic stage this soil is often generally poor in calcium carbonate.

The basalt soils are in general readily distinguishable from the terra rossa by their brown or chocolate-brown colour. According to REIFENBERG (1938) this colour in basalt soils is due at least partly to its large content of ferrous iron, as compared with terra rossa, the ratio ferric : ferrous being in a certain sample in basalt soil 10 : 4, and in terra rossa 10 : 1.

In its oropedic facies the soil is often very shallow, having no developed profiles. The rock underlying this soil consists often of large rounded boulders, for example, in the mountain slopes of Lower Galilee. On the contrary the transported basalt soil is always of considerable depth and very heavy. According to RAVIKOVITCH (1941), who studied this soil in the eastern part of the Esdraelon Plain, the ratio of clay+silt at Beit Hashita is 56,3% at a depth of 100-150 cm. In connection with the high clay content the water retaining capacity is here very high and the percolation of water very slight. The calcium carbonate in this locality reaches 15-20%. Due to poor drainage conditions to which this soil is subjected and to its physical properties it tends to salinization, especially where irrigation water is comparatively rich in soluble salts.

In its natural vegetation, basalt soil of Palestine does not constitute a uniform type, since a part of its area is dominated by Mediterranean climate and another part by Irano-Turanian climate. But even in those basalt areas which belong to the Mediterranean territory, no typical Mediterranean vegetation (such *Poterietum spinosi, Thymetum capitati, Cistetum villosae* and others) occurs. Instead of a herbaceous vegetation of semisteppe nature appears which in its phytosociological and syngenetical character exhibits no clear relation to the Mediterranean climax communities of the country. For example, *Feruletum communis* and the association of *Carlina corymbosa — Convolvulus Dorycnium* may be mentioned. As to arboreal vegetation of the basalt soils in general mention may be made of the following plant communities.

(1) *Zizyphetum Loti.* This Irano-Turanian plant association is widely distributed over the whole basalt area. It is, however, primary only within the limits of the Irano-Turanian territory (e.g. SE of the Lower Galilee).

(2) *Quercetum ithaburensis.* This association has been mentioned in connection with the Mediterranean white soils. In the basalt area remnants of this association occur in the Huleh Plain and in some other parts belonging to the Mediterranean territory. From its distribution in Palestine and Syria we know,

however, that *Quercetum ithaburensis* is limited to habitats unfavourable for typical Mediterranean forest association either edaphically or climatically.

(3) *Pistacietum atlanticae*. Of this forest type rather typical for Irano-Turanian and Mediterrano—Irano-Turanian districts in North Africa, in the Syrian Desert and in Transjordan we find only scant remnants here.

We have sufficient evidence to believe that the nearly complete lack of eu-Mediterranean arboreal vegetation in the basalt areas is not merely a result of extreme deforestation and destruction of vegetation by man. It may perhaps be assumed that the basalt oropedic soil, due to certain physical and chemical properties, does not offer suitable conditions for the development of typical Mediterranean arboreal vegetation at least under the climatic conditions mentioned above.

As to the agropedic facies its flora and vegetation differ only slightly from those of the transported terra rossa, and here too no traces whatever of the previous primary vegetation are to be encountered. On the other hand, well developed segetal plant communities such as *Prosopis farcata — Cynara syriaca* and some other associations of the *Prosopion farcatae* prevail here, while single trees or groups of *Zizyphus Spina Christi* are scattered here and there.

### (iii) *Sandy and sandy-calcareous soils*

In this category of soils we include some soil varieties of the Palestine Coastal Plain, the Negeb, and Southern Transjordan. Most are eolic in origin ; some of them have undergone secondary pedogenetical changes, resulting in decalcification, pan formation etc. The main soil varieties dealt with under this heading are : sand dunes, kurkar soils and red sands. The group of light soils of the Coastal Plain is of great interest, as it constitutes a natural unit in genesis, ecology, flora and vegetation.

#### (1) *The coastal sand dunes*

The sand dune belt occupies a considerable area along the Mediterranean coast. In the south it broadens markedly and joins the coastal and interior sand dune areas of the Sinai Peninsula. According to Blake (1936) this sand is made up principally of silica grains with some hornblende, mica, feldspar and shell fragments. It is brought to the shores of Palestine from the Nile by means of longitudinal currents, passing near the Palestinian coast. The sands accumulate into dunes, overlying red sand (sandy clay) or kurkar layers. A sample of this sand from the environs of Haifa shows after Blake (1936) the following composition :

| | | | | | |
|---|---|---|---|---|---|
| $SiO_2$ | — 82,20% | $Al_2O_3$ | — 1,95% | $CO_2$ | — 6,82% |
| $Fe_2O_3$ | — 0,25% | CaO | — 8,86% | $H_2O$ | — 0,2% |

The calcium carbonate in the dune sand increases generally towards the North. Another sample taken from the environs of Nathania showed the following proportions: clay—traces; silt—2,5; fine sand — 80,1; coarse sand — 17,4; amount of soluble salts — 0,47; Cl—0,003; $CO_2$—0,04.

*Vegetation.* Due to its chemical and mechanical composition and in the first place perhaps to its mechanical instability, the dune sand represents the most meagre habitat for plant growth. EIG (1939) to whom we owe a fundamental study of the vegetation of the light soil belt, was the first to distinguish in dune vegetation two main units: the one is characteristic of shifting dunes, the other of semistable and stable dunes. The shifting dunes are characterized by the *Ammophila arenaria — Cyperus conglomeratus* association, well developed only in the Shefela otherwise fragmentary. In the extreme south as well as in sand dunes of Sinai, *Aristidetum scopariae* is characteristic. Besides these two associations. *Polygonetum equisetiforme* (made up chiefly of *Polygonum equisetiforme* var. *arenarium*), *Panicetum turgidi* occur as excellent sand binders. In the southern part of the coastal dune belt *Tamarix pseudo-Pallasii* Gutm. inhabits the front dunes and has shown itself most efficient in the fixation of the coastal dunes. Since the question of inward advancing of sand dunes is rather serious in Palestine, especially in the south, these plant associations may be important from the practical point of view.

Semistable dunes situated in more or less calm places are characterized by the *Artemisia monosperma — Cyperus mucronatus* association. This plant community is much more permanent than those above mentioned. The number of its components is initially rather small, but in the course of its development an increase in species takes place The final stage of vegetational development in the fixed dunes is represented in the middle and northern parts of the Coastal Plain by the *Ceratonia siliqua — Pistacia Lentiscus* association. (EIG 1939). It may however be noted that *Artemisia monosperma* is not so effective in sand binding as to allow of a progressive development of the sere. Due to occasional changes in wind direction and other factors, resulting in a carrying-off or levelling of the sand dunes, the *Artemisietum* may be destroyed long before it has reached its final stage of development. That is no doubt the reason why only small areas of the sand dune belt are actually occupied by the climax vegetation (Plate VIII A).

The deep and narrow valleys between the high dune hills show high moisture content accumulated from surrounding dunes. In these valleys one often encounters fragments of hydrophytic plant communities, especially of *Juncetum acuti*. In the south such valleys are utilized for agriculture, but they could no doubt

be useful for tree growth which are apt to check the movement of the sand dunes.

Behind the front dunes flat or wavy sand fields occur, especially in the south. These plains are characterized by the *Lithospermum callosum — Scrophularia hypericifolia* association (Eig l.c.). The soil is here often too loose to allow of the establishment of field crops, but is suited to the culture of certain fruit and forest trees. Figs, grapes, sycomores, almonds are extensively grown in these valleys of the Gaza district, and as far south as Rafah. The Forest Department of the Palestine Government has afforestated such areas in the Gaza districts (*Acacia*) with considerable success.

(2) *Red sand (sandy clay)*

This soil variety is the most abundant and agriculturally the most important of all the light soil varieties of the Coastal Plain. It extends from the Acre Plain along the greater part of the Sharon and the northern part of the Shefela. It is a light sandy-clay soil, reaching a considerable depth, sometimes as much as several metres. Chemically it is characterized by the high amount of silica (up to 90%) and the amount of sesquioxydes exceeding that of dune sands. But its most striking feature is the total or nearly total absence of calcium carbonate. A sample of this soil from the environs of Sarafand shows the following composition:

| depth in cm. | 5-10 | 10-20 | 20-30 | depth in cm. | 5-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| $H_2O$ %(105°) | 1,6 | 2,4 | 1,9 | water soluble salts | 0,035 | 0,045 | 0,041 |
| $CaCO_3$ | — | — | 0,7 | Cl | — | — | — |
| clay | 6,2 | 6,2 | 5,0 | $CO_2$ | — | — | 0,31 |
| silt | 1,3 | 7,5 | 1,2 | pH | 7,1 | 7,2 | 7,0 |
| fine sand | 85,3 | 79,3 | 87,5 | | | | |
| coarse sand | 5,6 | 4,6 | 3,7 | | | | |

From several analyses at our disposal it is obvious that the amount of silt and clay increases with the depth, while that of the sesquioxydes does not vary with the depth (Menchikovsky 1938). The reaction is often neutral or nearly so. As it is the typical soil of the *Citrus* groves in Palestine it has been subject to investigation by Menchikovsky (1938), Puffeles (1937), Ravikovitch (1935), Reifenberg and Adler (1934), etc. so that the reader may be referred to these sources for the detailed information.

As to its evolution the opinion is now held that the calcareous sandstone of the kurkar hills may be considered the parent rock of this soil (Loewengart 1928), Picard and Avnimelech (1937). In the course of evolutional processes a complete removal of the calcium carbonate and an enrichment of sesquioxydes takes place. While in the parent material the sesquioxydes may not exceed

1%, in the red sands it may reach 15%-18% and more. It is, however, doubtful if red sand formation is taking place also at present.

*Vegetation.* There is a well defined successional sere of plant communities confined to this soil. The initial stages of this sere consist of a few herbaceous plant associations such as *Ormenetum mixtae* (EIG 1939), *Trifolietum palaestinae* and others. They are the first to inhabit fallow fields and neglected citrus orchards. Fragments of these associations also occur commonly as weeds in the cultivated non-irrigated crops of the light soil. The next main stage of this sere is the *Eragrostis bipinnata — Centaures procurrens* association (EIG 1939). It is extraordinarily rich in species and much more permanent than the initial associations of the sere. *Eragrostis bipinnata*, the leading species of this association, is a tall tufted grass of the Saharo-Sindian element. lending the landscape the appearance of a grass steppe. The last stage of the sere is a variety of *Quercetum ithaburensis.* This oak forest is at present heavily devastated and only poor remnants, single trees or groups of trees, are scattered here and there amongst the high "hilfa-grass" (*Eragrostis*). The final devastation of this forest took place in recent times and travellers of the second half of the last century, who passed this area still described dense stands of this oak. From the actual distribution of this forest tree in the Coastal Plain, as well as from the fact that no remains of other Mediterranean trees were found here, it is obvious that the oak in the recent past formed here a kind of a park forest, in which *Eragrostis* formed the grass layer. The occurrence of the Saharo-Sindian *Eragrostis bipinnata* as a leading plant of a permanent association within a Mediterranean successional sere seems to be strictly conditioned by the decalcified soil of this area ; otherwise *Poterietum spinosi* or other batha and garigue associations would link themselves to this sere, as they elsewhere do (Plate VIII B).

The *Eragrostis* association is the best indicator of soils suited to citrus cultivation, and in fact almost all the citrus orchards of the Sharon Plain and Northern Shefela are planted on *Eragrostis* soil. In the Southern Shefela, kurkar hills are still abundant but they do not weather into red sand free of calcium carbonate. This may perhaps be the reason why in this region the association of *Eragrostis bipinnata* is entirely lacking, and *Poterietum spinosi* and sometimes other Mediterranean batha and garigue associations are most characteristic of this area.

In the midst of the red sand area a soil variety locally termed "nazaz" is encountered. It is an impermeable pan-like red-brown to blackish soil layer, varying in depth, mostly underlying the red sand layer, but sometimes appearing also at the surface. It is devoid of or extremely poor in calcium carbonate, contains a high ratio of sesquioxydes and has often a somewhat acid reaction. As it is rather common in the whole red sand belt of Pa-

lestine and represents a serious obstacle to *Citrus* growing it has been subject to close investigation by some pedologists. Menchikovsky (1938) considers the nazaz as a degradated soil derived from the red sands through an excessive accumulation of iron and aluminium, washed down from the upper sandy clay layer. The colloidal fractions found in the lower soil layers are considerably higher than those of the upper layers. A sample, of this soil from the Kubeba area (near Rehovot) shows according to Menchikovsky and Adler (1930) that the silt-clay fractions amount here to 45,5%, three times more than in the red sand layer of the same locality. But the outstanding features of this soil are expressed by the comparatively high percentage of iron and aluminium (in the above mentioned sample 4,02% for $Al_2O_3$ and 12,25% for $Fe_2O_3$). Reifenberg (1938) assumes that the colloidal particles, here very finely dispersed, cause the pores of the nazaz soil to be choked, and the finely divided iron compounds are responsible for its hardening and cementing. The formation of nazaz was also studied by Puffeles (1937), to whom the reader may be referred.

Vegetationally those spots, which contain a superficial nazaz horizon in their profils, are characterized by the sub-association *Eragrostis bipinnata — Centaurea procurrens—Imperatosum* (Eig 1939). Here *Eragrostis* is replaced by *Imperata cylindrica*, a grass similar in appearance to *Eragrostis* but generally confined to heavy moist or swampy soils.

Mention should here be made of another variety of the red sands limited to the elevated shore and its steep escarpments facing the Mediterranean Sea. It is a sandy clay exposed to the direct action of the wind and presumably containing slight amounts of sodium chloride, brought with the drops of sea water. Although limited in surface and not suited to agriculture, it should be investigated from the point of view of soil conservation by afforestation. In its vegetation it differs markedly from the red sand mentioned above by two or three plant communities of which the *Lotus creticus — Sporobolus arenarius* association (Eig 1939) is the most characteristic.

(3) *Kurkar soils*

One of the most striking geo-pedological features of the Coastal Plain is the appearance of calcareous sandstone hills, commonly termed "kurkar hills". They are mostly arranged in longitudinal rows interrupted by valleys of the red sand soil. In contradiction to the view of the earlier geologists these hills are now considered by Loewengart (1928), Picard and Avnimelech (1937), Picard (1938), as older dunes, diagenetically hardened and cemented by solutions of calcium. Borings and freely exposed profiles in this hill region show that in several places these calcareous sandstone strata overlie thick layers of a compact red of

brown sandy loam, which in its turn cover other deep-seated kurkar strata. The kurkar appears as fine layers of friable sandy-calcareous concretions or as consolidated rocks of considerable thickness. The former weathers generally into a coarse loose sand, the latter into a sandy loam.

In the following some analytical figures are recorded for sandy friable kurkar soil (Nahlath Itzchak near Ramath Gan, *Helianthemetum elliptici*).

| depth in cm. | 15 | 40 | depth in cm. | 15 | 40 |
|---|---|---|---|---|---|
| $H_2O$ % (105°) | 1,4 | 1,2 | water soluble salts | 0,100 | 0,054 |
| $CaCO_3$ | 13,8 | 17,8 | Cl | 0,002 | 0,025 |
| clay | — | — | pH | 7,6 | 7,6 |
| silt | 3,75 | 5,0 | | | |
| fine sand | 59,7 | 26,1 | | | |
| coarse sand | 21,3 | 49,9 | | | |

In other samples the amount of calcium carbonate is considerably higher (10—25%).

The natural vegetation of the kurkar hills is represented by a series of well-defined plant communities, each confined to a definite developmental stage of the soil.

(1) On calcareous-sandstone concretions *Helianthemetum elliptici* (Eig 1939) is the only plant association. The leading plant of this association, as well as other important components (e.g. *Retama Roetam, Salvia lanigera, Gypsophila Rokejeka, Heliotropium rotundifolium* etc.) are Saharo-Sindian or Irano-Turanian species. In spite of the typical Mediterranean climate, to which these hills are exposed in the Sharon and the Shefela, no Mediterranean associations are able to get a foothold in this extremely poor and dry substratum.

(2) The aforementioned skeleton soil weathers generally to a coarse sand accumulating at the foot and the lower slopes of the hills. Here the association of *Ononis stenophylla — Convolvulus secundus* (Eig 1939) fully characterizes this stage of soil development.

(3) For those kurkar hills built up of more or less consolidated rocks an association of *Thymus capitatus — Andropogon hirtus* is most characteristic. This association occurs also on compact loams generally underlying the kurkar and sometimes appearing on the surface after denudation of the kurkar strata.

(4) The consolidated kurkar rock seems to weather to a red or brown sandy loam, on which a kind of *Poterietum spinosi* or an association of *Poterium spinosum — Thymelaea hirsuta* are established. It is this loam, which after decalcification turns into the red sand (sandy clay) mentioned above.

The aforementioned varieties associated with the kurkar hills are far from embracing the whole gamut of light soils of the Coastal Plain. The origin of the kurkar hills and their relation to

the various soils in question has as yet not been satisfactorily explained either by pedologists or geologists.

(4) *Desert sands*

In contradiction to conventional opinion, sandy soil and sand dunes in the desert are more fertile than other desert soils. One encounters on sandy deserts a comparatively rich flora and vegetation. This is due to the following facts: sand dunes enrich the relief features and lead to a differentiation of habitats. Due to its physical properties, sandy soil is poorer in toxic salts than other desert soil. Desert soils covered even superficially by sand are richer in vegetation than soil of the same climatic conditions destitute of a sandy cover, since the sand cover protects the subsoil against extreme evaporation.

Interior sand deserts are encountered in Palestine in three distinct regions: the western part of the Negeb, the eastern part of the Negeb and south-eastern Transjordan.

In the western Negeb sands appear as huge dunes, forming a continuation of the coastal dunes of Palestine and Sinai and probably of the same origin as the latter. Here *Artemisia monosperma* as well as *Aristida scoparia* play an important part in the vegetation cover.

In the eastern Negeb the dunes and the sandy soils are derived from the Nubian sandstone of the Kurnub sector. Among other associations a kind of *Retametum Roetami* and *Anabasidetum articulatae* are most abundant here.

In the southeastern Transjordan (Edom) both Nubian sandstone as well as igneous rock weather to sands which accumulate into dunes and sandfields.

A sample taken from sand deriving from Nubian Sandstone (Edom, 43 km. S of Ma'an) showed the following composition:

| depth in cm. | 0-10 | 10-20 | 20-30 | depth in cm. | 0-10 | 10-20 | 20-30 |
|---|---|---|---|---|---|---|---|
| $H_2O$ % (105°) | 0,6 | 0,9 | 0,9 | water soluble salt | 0,050 | 0,040 | 0,052 |
| $CaCO_3$ | 0,31 | 0,71 | 0,81 | Cl | 0,003 | 0,002 | 0,002 |
| clay | — | — | — | $CO_2$ | 0,14 | 0,33 | 0,37 |
| silt | — | 1,21 | — | pH | 7,6 | 8,2 | 7,7 |
| fine sand | 71,39 | 64,79 | 93,49 | | | | |
| coarse sand | 27,7 | 32,4 | 4,8 | | | | |

The plant associations characteristic for these sandfields are *Zilla spinosa — Noea mucronata* association, *Zilla spinosa — Anabasis articulata* association and others. Though exposed to extreme conditions (annual precipitation ca. 50 mm.), they are comparatively rich in species. The leading species of these associations are not psammophytes (Plate IV A — p. 96, Vol. II, No. 1).

The other variety of desert sand derived from igneous rocks in the Akaba district (Wadi el Madeifan) showed the following composition:

| depth in cm. | 0-10 | 20-30 | 40 | depth in cm. | 0-10 | 20-30 | 40 |
|---|---|---|---|---|---|---|---|
| $H_2O$ % (105°) | 2,8 | 1,5 | 1,2 | water soluble salt | 0,167 | 0,100 | 1,02 |
| $CaCO_3$ | 23,1 | 11,6 | 11,8 | Cl | 0,004 | 0,005 | 0,004 |
| clay | 2,5 | — | 1,2 | $CO_2$ | 10,6 | 5,3 | 5,4 |
| silt | 23,7 | 5,0 | 3,8 | pH | 8,4 | 8,6 | 8,5 |
| fine sand | 46,7 | 75,7 | 62,0 | | | | |
| coarse sand | 1,2 | 6,2 | 20,0 | | | | |

This soil is taken from a depression and is therefore much heavier than the former.

Here we noted the occurrence of three plant associations: *Artemisietum judaicae*, *Haloxylonetum salicornici* and *Haloxylonetum persici* (?). The latter is of particular interest, being the only desert association the leading plant of which is a tree or a high shrub. It is very abundant in Wadi Araba. It recalls the "Saxaul Forest" of the Aralo-Caspian countries and plays a similar important rôle in supplying fuel to the desert inhabitants. It may be remarked here that large tracts of the Arabian Nefud sands are occupied by such "Saxaul Forests" (ZOHARY 1940).

### (iv) *Loess and loess-like soils*

#### (1) *The loess soils of the Negeb*

The loess covers a continuous area in the near Negeb, especially in the Beersheba-Gaza district, and penetrates deeply into adjacent districts along plains and wadis. RANGE (1922) was the first to deal with this soil. He considered it as a soil of eolian origin, partly redeposited by water. A redeposition of it is occurring at present also in the main wadis of the Negeb. In the environs of Wadi Gaza RANGE (l.c.) describes a layer of loess soil overlying an Egyptian culture horizon dating from 2000 years B.C.

It is generally a fine-grained soil with a medium ratio of clay and silt but a high percentage of fine sand (up to 70%). According to PUFFELES (1939) it is easily permeable to air and water and exhibits good physical properties, but it is poor in nutrients. It contains a comparatively high amount of lime. A sample from the environs of Beersheba analysed by REIFENBERG (1938) showed the following composition:

| | | | |
|---|---|---|---|
| $SiO_2$ | 59,97% | $Na_2O$ | 0,97% |
| $Al_2O_3$ | 4,30% | $P_2O_5$ | 0,11% |
| $Fe_2O_3$ | 3,40% | $SO_3$ | 0,23% |
| CaO | 12,70% | $CO_2$ | 10,93% |
| MgO | 1,58% | $H_2O$ | 5,24% |
| $K_2O$ | 0,61% | | |

As to the geographical extent of the loess in the Negeb there is a diversity of opinions. According to RANGE (1922) this soil extends northwards as far as an approximate line from Gaza to Ruhama. BLAKE (1939) draws this line farther north, while

PICARD and SOLOMONICA (1936) diminish the area of the loess distribution in the Negeb to the Beersheba Valley and its adjacent wadis. Our investigations (FEINBRUN and ZOHARY 1942) confirm RANGE's statement. But it must be remarked that this soil is not uniform in its composition over the whole area of its distribution. In certain areas the loess contains much more lime than reported here. In others the fraction of coarse sand is considerably higher than characteristic for this type. Bordering in the west with the coastal sands and in the East with the Senonian hill country the loess passes gradually to sand soil on the one hand and to grey steppe soil on the other.

As to the vegetation it may be noted that the soil in itself could be successfully exploited agriculturally were it not limited to a region whose annual amount of precipitation is below 300 mm. and in part below 200 mm. Despite this climate loess is the most productive soil among the steppe and desert soils due to its relatively high capacity for retaining moisture. Not only winter wheat and barley are extensively cultivated here, but even summer crops such as sorghum and water-melons.

The natural vegetation of the loess district was recently investigated by ZOHARY and FEINBRUN (1942). The authors distinguish between the segetal and non-segetal plant communities. The segetal communities belong to the *Achilleion Santolinae*, which is represented here by two associations: the *Achillea Santolina — Hyoscyamus reticulatus* characterizing deeper soil in the West and in the East of Beersheba, and *Achillea Santolina — Ixiolyrion montanum* association, limited to the env. of Beersheba, where the loess cover is shallow and contains gravel and pebbles transported from the adjacent Senonian hills. Here *Trigonella arabica* plays an outstanding rôle in its high degree of covering. A striking vegetational feature of the loess fields is the complete absence of *Prosopis farcata*, a plant designating agricultural lowlands of Palestine. Since the transformation of steppes into grainfields caused here, as elsewhere in the Irano-Turanian region, but little change in the edapho-ecological constitution of the habitat, a considerable number of "weeds" in such "steppe fields" may be regarded as autochtonic, namely as members and survivals of the preanthropous vegetation of the district.

As to the non-segetal associations only remnants of one association could be noticed here: the *Asphodelus microcarpus — Salvia lanigera* association, occurring mainly on field borders and in fallow fields. Though fragmentary in its appearance there is much evidence to regard this association as an initial stage of a successional sere tending to climatic climax association of the loess area. Considering the phytogeographical relations and the ecological conditions of the region, one may assume a kind of *Artemisietum Herbae albae* as the climax association of the whole loess area of the Northern Negeb.

In the southern part of the Negeb as well as the northern part of the Sinai Peninsula, loess occurs only in deeper valleys, depressions and on banks and beds of wadis. Being mostly a fluviatile redeposition, this soil is here considerably richer in moisture and nutrients and is suitable for agriculture even in places where the amount of annual precipitation does not exceed 100 mm. The natural vegetation of this kind of loess is well represented here by a more or less typical *Haloxylonetum articulati.*

(2) *The loess soils of other deserts*

Apart from the classical loess area of the Negeb there are in Palestine large tracts of loess within the eastern steppe and desert part of the country. In the southeastern part of the Judean Desert as well as in the Transjordan Plateau this soil is often cultivated and exhibits the same segetal vegetation characteristic of the loess of the Negeb. But here the cultivation did not cause total devastation of the primary vegetation as it did in the Negeb. One still finds here (Transjordan) large stretches of loess covered by intact *Artemisietum Herbae albae* on the one hand and fallow fields being reoccupied at present by this association on the other. Future pedological studies should devote much attention to these cultivable soils of the steppe and deserts. The sources of this inblown soil seem to us to be not the desert sand dunes, as commonly believed, but the great hammada plains bordering the loess soil from the South and East. These plains exhibit as already mentioned a fine powdery soil intermingled with pebbles. Being deprived of sufficient moisture and vegetation the wind blows the fine dusty grains from the soil to the more inwardly situated *Artemisietum* lands.

Besides typical loess there are also soil transitions in this region between the grey steppe soil and the loess.

(3) *Loess-sand soil*

Advancing towards the southern boundary of the country, we find a considerable belt of loess in the western part of the Negeb covered by a more or less thick layer of quartz sand (ZOHARY and FEINBRUN 1942). From the pedological point of view this soil does not merit special attention since the two layers, the loess and the sand, are here identical with those described above. Ecologically, however, this soil constitutes a special unit due to its higher content of moisture, caused by the interrelationship of the two soil strata. The underlying loess with its relative high capacity for retaining moisture, obtains abundant moisture through the readily percolating sand layer and the latter in its turn serves as very efficient protecting cover against the evaporation of the loess layer. Due to this property the loess-sand soil is agriculturally highly appreciated in this part of the country. Wheat, barley and even summer crops such as sorghum and watermelons are cultivated on this soil since ancient times and even almond

and apricot orchards are established here without watering, although the annual amount of precipitation does not reach even 200 mm.

The natural vegetation of this soil is purely Saharo-Sindian. The climatic climax seems to be represented here by a special variety of the *Artemisietum monospermae*, the detailed composition of which is not adequately known to us due to human interference. On the other hand, we are well informed of the segetal and subsegetal association of the grainfields of this area. An association of *Cynodon dactylon — Leopoldia arenaria* with the prevalence of *Scleropoa memphitica*, is the most characteristic segetal association. *Cynodon dactylon* is here exceedingly important in binding the sand cover and protecting it against deflation. Of the other associations the following may be mentioned tentatively: *Aegilopetum bicornis, Lolietum multiflori, Asphodeletum tenuiflori* etc. It is highly possible that these therophytic associations are different facies of one and the same association, each confined to certain physical and chemical conditions of the same soil (degree of compactness, deficiency in $CaCO_3$ etc.). On the other hand there is evidence to believe that these associations represent different successional stages, tending to the climax after the fallowing of the field.

### (v) *Alluvial soils*

Under this heading we comprise a series of soils seasonally or permanently inundated by water or strongly influenced by a comparatively high groundwater table.

The term "alluvial soil" is thus adopted here only in its true pedological and ecological sense and not in its broad geological meaning. Accordingly it includes only soils of more or less hydrophytic habitats. Those soils commonly termed by local pedologists as alluvial are included among the so-called transported soils, dealt with in the earlier chapters, each in connection with oropedic facies of the same type. The saline soils of Palestine though mostly hydropedic in their main character, will be dealt with in the next chapter.

The alluvial soils and their vegetation present very striking features of the otherwise rather xerophytic landscape, particularly in the desert areas, where they constitute vivid green oases. Alluvial soils occur in Palestine mainly in both its hydrographic regions, viz.: the Coastal Plain and the Jordan Valley. The Coastal Plain is characterized by a number of latitudinal rivers and rivulets, some of them permanent, emptying into the Mediterranean. Since the kurkar hills and the dunes are arranged here in a longitudinal direction, the outpouring of these rivers into the Sea is markedly impeded; hence the occurrence of considerable areas of swampy soils in the vicinity of recent or ancient water courses. Such areas are found in the vicinity of

Wadi Rubin, Yarkon River, the Askanderun River, the Mufajar, the Zerka, the Kishon, etc. Comparatively large stretches of swampy soils in the Sharon and Acre Plain, mostly unexploited for thousands of years due to unfavourable conditions both for men and agriculture were only recently drained.

The second centre of alluvial soils is the Jordan Valley. The Jordan River and its tributary river net, the Huleh Lake and its swamps, the Sea of Kinereth and the latitudinal water courses, emptying into the Dead Sea, are responsible for the occurrence in this valley of considerable areas of alluvial soils in various developmental stages.

A series of smaller areas of hydropedic soil occur in addition in the Esdraelon Valley as remnants of ancient swamps. Since very little has so far been done in pedological investigation of these soils, only a cursory description of the external features of these soil varieties may be given here. On the other hand, an enumeration of the vegetational units characterizing these soils will doubtless supply a considerable aid to pedological interdistinction of the various soils in question.

(1) *Soils of swampy ponds*

These are permanently submerged soils. For example we may mention here the Huleh Lake. This lake is a shallow basin not exceeding 3 m. in depth. The bottom is covered by a deep layer of greyish or brownish mud, formed by the deposition of silt, intermixed with plant debris. The pH value of the water is according to JONES (1940)—7,6. The following phanerogamic plant associations appear in this lake according to JONES (1940) and our own observations: The association of *Nuphar luteum — Ceratophyllum demersum* is confined to places with shallow water and a thick mud layer very rich in plant debris. In places with more open and somewhat deeper water stands of *Myriophyllum spicatum, Potamogeton lucens* occur, while the association of *Vallisneria spiralis — Najas marina* is limited to the marginal zone of the lake. The vegetation seems to be here differentiated according to depth of water, light intensity and probably also to the depth and composition of the silt. Small natural ponds of somewhat similar vegetation are scattered here and there in the midst of the Huleh swamp. Two other ponds (Birket Battich and Birket Attah) have existed in the Sharon Plain until recently. Their vegetation somewhat resembled that of the Huleh Lake.

EXPLANATION OF PLATE VIII

A: Semistable sand dunes occupied by the association of *Artemisia monosperma — Cyperus mucronatus* at Hadera (Sharon). Single trees of *Ceratonia Siliqua* and *Pistacia Lentiscus* mark the advanced stage of this association.

B: Red sand (sandy clay) at Pardess Hana (Sharon). The association of *Eragrostis bipinnata — Centaurea procurrens* and *Quercetum ithaburensis* appear side by side.

C: Banks of the Yarkon River (Sharon). *Salicitetum acmophyllae.*

A

B

C

ZOHARY — VEGETATIONAL ASPECT OF PALESTINE SOILS

(2) *Bank loams*

These soils are flooded mainly during the winter by water courses or natural ponds. It is a heavy loam with a high capacity for retaining water, which generally does not dry out in summer to such an extent as to form polygonal cracks. It is frequently but not always suited for cultivation of summer crops only, and is characterized by a complex of vegetational units exhibiting a more or less regular zonal arrangement. The following plant associations may be mentioned here as most common:

(1) *Phragmites communis — Typha angustata* association (and its varieties), occupying the first zone (nearest the open water, sometimes emerged in water). It is the most abundant plant community and is confined to low banks in all parts of the country.

(2) *Panicetum repentis* occupies the second zone. It is well developed only in the Huleh swamps, otherwise fragmentary.

(3) *Juncus acutus — Inula viscosa* association always occupies the exterior zone of the bank or the foreshore. Sometimes it appears in two distinct zones: one of *Juncus acutus*, the other of *Inula viscosa*. This association is often well developed both in the Coastal Plain and in the Jordan Valley. In the Huleh swamps other zones of plant associations are intercalated between zone (2) and (3).

These three plant associations should be included within the *Phragmition* alliance, which characterizes periodically inundated soils of flat banks with a high quantity of moisture even in the dry summer season.

Another group of plant associations characterizing elevated river banks are the *Rubus sanctus — Lythrum salicaria* association and its allies. They constitute a particular alliance, the *Rubion sancti*, which probably includes also a series of arboreal plant associations. These are *Salicetum acmophyllae*, *Platanetum orientalis*, and association fragments of *Fraxinus syriaca* and *Alnus orientalis* (Plate VIII C).

A third alliance of associations which should be mentioned here is the *Populion euphraticae*, confined to the banks of the Jordan River and some of its tributaries. It comprises the *Populetum euphraticae* (close to the water course) and the *Tamaricetum Jordanis* (forming the outer zone; soil somewhat saline). Both constitute the Gallery Forest of the Jordan (in its lower and middle part mainly). The soil of this vegetation belt is under cultivation in several places.

(3) *Black and grey loams*

This series comprises rather small isolated areas of heavy soils limited to plains and lowlands, often in the vicinity of recent or ancient swamps or water courses. They are mostly placed outside of flood zones and are not directly influenced by open

water sources. Due to relief conditions they are occasionally flooded by accumulating rain water for longer or shorter periods.

The following habitats may be tentatively included into this series: (1) dried-up swamps still retaining their hydropedic character, (2) soils inundated during winter and dried out in summer, (3) soils with high groundwater table, (4) bottoms of ephemeric water courses (wadis). The common characteristic of these soils are the high water content, the comparatively high clay and humus content, the poor aeration etc.

Agriculturally these soils are particularly suited to summer cultures. Of the natural vegetation characteristic of such soils we mention here a few plant communities: (1) *Glycyrrhizetum glabrae* (inundated soils of the Sharon and Beisan Plain etc.). (2) *Prosopis farcata — Alhagi Maurorum* association (Huleh Plain). (3) *Prosopis farcata — Phragmites communis* association (Hefer Plain). (4) *Xanthium strumarium — Pulicaria dysenterica* association (Huleh Plain, Kabbara). (5) *Imperatetum cylindricae* (Beisan Plain). (6) *Viticetum Agni Casti* (banks of dry wadis, everywhere).

These however constitute only a small part of the vegetation units characterizing these soils. They are not adequately studied and they are here tentatively named only. No mention is made here of the vegetation of rocky banks and brooks.

(4) *Oases soils*

One of the most striking geobotanical features of the Lower and Middle Jordan Valley as well as of Wadi Araba is the occurrence of a number of oases, designated when in natural conditions by a Sudano-Deccanian flora and vegetation. These oases are often separated from one another by portions of saline or non-saline desert land. They are confined to special hydrographical conditions, namely to the so-called "aires d'eppendage" of the larger water courses, emptying into the Jordan Valley. These water courses have mostly also deposited in their outlet region more or less deep layers of loams of different lithological origin, transported from the adjacent mountains or even from remote parts of the mountain region. This allochtonic loam mostly overlies the original lissan marl and may achieve a depth of several metres (for example in Wadi Araba). Its colour red, brown, yellowish or even grey, seems to depend upon the parent material from which it is derived. There are thus three main edaphical factors conditioning the occurrence of such fertile oases in the Jordan Valley and Wadi Araba: (1) the removal of chlorids by permanent currents of surface water, (2) the accumulation of a more or less thick layer of soil with comparatively high moisture capacity, and in the same time rather good drainage conditions, (3) surface or underground water sufficient for tree growth.

PUFFELES (1936), who surveyed the soils of the Lower Jordan Valley on a larger scale found a diversity of variations in respect to salinity, moisture, amount of carbonates etc. Unfortunately he did not class the examined samples according to the different habitats which are so clearly characterized by vegetation.

The natural vegetation of these oases soils comprises a few arboreal plant communities, the most important of which are those dominated by *Acacia tortilis* which in its distribution does not advance norther of Jericho, and the *Zizyphus Spina Christi — Balanites aegyptiaca* association, advancing as far north as the Beisan Valley. The main phytogeographical feature of this vegetation is that the leading species and some other components of these associations belong to the Sudano-Deccanian element which in Palestine is concentrated chiefly in enclaves (oases) of the Lower Jordan Valley. Of the other trees and shrubs represented in some of these enclaves the following may be mentioned here: *Salvadora persica, Moringa aptera, Maerua crassifolia, Capparis decidua, Abutilon fruticosum, Abutilon muticum, Callotropis procera, Cordia Gharaf, Solanum incanum, Tephrosia Appolinea*, etc.

At present the primary associations of these enclaves are seriously affected by man, who has turned these enclaves to oases with very primitive agriculture. One of them is Jericho. Of the other enclaves Ghor es Safi, Ghor el Feifeh (in Wadi Araba), Ein Geddi, Wadi Auja, Wadi Fara, Wadi Milh may be mentioned. The Beisan Valley fed by a series of springs and rivulets constitutes the last and northernmost etappe of this chain of oases, though the Sudano-Deccanian element is here very scantly represented.

(5) *Irrigated soils*

Considerable stretches of heavy soil at present under irrigation may be classed within the alluvial soils. While in the arid parts irrigation is practised during the whole year (Beisan Valley etc.), in Mediterranean soils there is only summer irrigation. The area of irrigated heavy soils of Palestine is increasing from year to year. Certain areas of heavy soil under irrigation incline to salinization (RAVIKOVITCH 1941).

The vegetation of the irrigated soils is represented by an association of the *Prosopion farcatae*, in which the Summer aspect is characterized by *Prosopis farcata* and a series of hydrosegetal species such as *Panicum colonum, Panicum sanguineum, Amaranthus graecizans, Amaranthus retroflexus, Portulaca oleracea, Cyperus rotundus* and others. These are the most typical and most abundant weeds of the irrigated heavy soils of Palestine. By this segetal summer flora the irrigated heavy soils differ markedly from all other non-irrigated soils.

The primary vegetation of this soils has already been mentioned above, in dealing with transported basalt and calcareous soils.

(6) *Peat soils*

This soil occurs in Palestine as a kind of lowmoor peat, found especially in the swampy part of the Huleh Plain which represents the largest swampy area of Palestine (about 5000 hectares in surface). It is situated in a depression between the mountains of Upper Galilee and the Golan and crossed by three rivers: the Jordan, the Tura and the Kali. The waters of these rivers are impeded in their course and permanently inundate the whole surface of the swamp, deposing great masses of mineral and organic matter. The abundance of water and organic matter gives rise to a highly luxurious hydrophytic vegetation, which in its turn supplies material for the deposition of a thick peat cover overlying a calcareous soil.

The chemical composition of this peat was studied by REIFENBERG and MOSHICKY (1941) from a peat profile about 100 m. N of Lake Huleh. Some figures concerning the composition of the peat may be quoted here (horizon F of a profile, placed between 70—90 cm. below surface): Water soluble fraction — 2,29; hemicelluloses — 7,07; cellulose — 4,24; lignin — 69,34 (in percentage of water free and ash free material). In percentage of the total dry matter the following figures are recorded: ether-soluble fraction—0,27; alcohol soluble fraction 0,66; water soluble fraction—1,49; hemicelluloses—4,60; celluloses—2,76; lignin 45,14; proteins—10,18; ash—25,72.

There is a good proportion of mineral matter in this peat. Due to its high content of calcium carbonate the pH value is here mostly neutral or even slightly alcaline.

The Huleh swamp harbours the most interesting type of hydrophytic vegetation of the Near East. Especially striking here is the strict zonation of the vegetation and the comparatively rich number of zones, each confined to special hydrographic — edaphical conditions. A transsection made from the centre to the periphery of this swamp shows according to ZOHARY and ORSHANSKY (1941) the following zonation of plant communities:

(1) *Cyperetum Papyri palestinum.* This association occupies the largest part of the swamp and is confined to peat soil, flooded during the whole or greater part of the year. In its natural composition this association consists only of a few components viz.: *Cyperus Papyrus, Polygonum acuminatum, Lycopus europaeus, Dryopteris Thelypteris* etc. When cleared by man a series of other components, partly photophilous like *Lythrum salicaria, Cynanchum acutum* etc., enter into its composition.

(2) *Polygonetum acuminati.* This association occupies a peripheral belt along the *Cyperetum* on the eastern and western

shores. It is ecologically confined to the *Cyperetum* and may perhaps be considered as a degradated photophilous facies of the *Cyperetum* and as an initial stage of succession leading to the *Cyperetum*. In places where the *Cyperetum* is permanently cut, it occupies large areas.

(3) *Phragmites communis — Typha angustata* association occupies the periphery of the peat swamp.

(4) *Sparganietum ramosi* forms another zone around the *Phragmites* girdle and seems not to be confined to peat soil. It is not always clearly distinguished from the latter zone.

(5) Another series of associations such as *Panicetum repentis, Cyperetum globosi, Glycyrrhizetum echinatae, Mentha aquatica — Cynodon dactylon* association, etc. characterize the outer zone of the swamp temporarily flooded and completely drying up in the drought season. The decisive ecological characteristic distinguishing these associations from one another seems to be the length of period during which the soil is subjected to inundation.

(6) *Juncus acutus — Inula viscosa* association. This association closes the swampy vegetation towards the peripherical segetal association of the *Prosopion* alliance.

In the northern part of the Huleh considerable areas of the swamp are now under cultivation. The peat soil is a light highly fertile soil as regards summer crops, such as corn and sesame. These crops exhibit a special weed flora, some components of which belong to the *Cyperetum Papyri*.

### (vi) *Saline soils*

The Palestine saline soils are chiefly solontchaks. There are two districts where these soils occur: the alluvial plains of the Mediterranean Coastal Plain and the Saharo-Sindian and Irano-Turanian Parts of the Jordan Valley and Wadi Araba. Only exceptionally does one encounter saline patches also in the hammadas of the Negeb and Transjordan.

To obtain a clearer view of the soil varieties in question and their distribution throughout the country, we subdivide them tentatively into the following three classes: (1) flooded solontchaks, (2) groundwater solontchaks, (3) automorphous solontchaks.

(1) *Flooded solontchaks*

(a) Littoral salt marshes. Marshes of this kind are very rare in Palestine. They are formed by flooding of the Mediterranean on flat shores. In Summer these flats dry up and give rise to surface salt depositions. No data is as yet available about the composition of this soil in Palestine. The vegetation of a salt marsh was observed by us only once in Athlith (Sharon Plain). The plant communities here are zonally arranged, starting from

*Salicornietum herbaceae* occupying the inner part of the marsh and terminating with an association of *Statice Limonium — Plantago crassifolia*, but the vegetation at this point appears very fragmentary and deserves further investigation. In the environs of Deir Ballah (S of Ghaza) littoral salt water ponds were observed by RANGE (1922) and by us (ZOHARY and FEINBRUN 1942). The vegetation of these ponds is a kind of *Phragmitetum* (first zone) and *Tamaricetum tetragynae* (second zone).

(b) Saline river-banks. We encountered such soils in the environs of Acre at the banks of the Naaman River. No data on the composition of this soil is available, but from the composition of the vegetation it is evident that a higher content of sodium chloride is present in this soil as well as in that of adjacent salt meadows. The vegetation is arranged in zones. *Arthrocnemetum glauci* accompanied by scattered specimens of *Tamarix tetragyna*, borders the river. Further inwards fragments of the association of *Statice Limonium — Plantago crassifolia* cover a considerable area.

(c) Dead Sea flood marshes (Sebkhas). The shores of the Dead Sea, especially those of its northern and southern flats, represent the greatest centre of halopedic soils and halophytic vegetation of Palestine. These shores are flooded seasonally at high water and exhibit the highest content of soluble salt ever found in Palestine. In some samples taken from this soil the amount of soluble salt reached 18% of total dry matter. The following figures were obtained from the soil characterized by an association of *Arthrocnemum glaucum — Tamarix tetragyna* on the NW flat of the Dead Sea:

| sample I | | | | sample II | | | |
|---|---|---|---|---|---|---|---|
| depth in cm. | 0-10 | 20 | 70 | depth in cm. | 0-10 | 30 | 60 |
| $H_2O$% (105°) | 5,1 | 4,5 | 8,0 | water soluble salts | 3,20 | 5,88 | 5,67 |
| $CaCO_3$ | 36,7 | 30,9 | 33,0 | Cl | 1,11 | 2,28 | 2,15 |
| clay | 6,2 | 1,2 | 5,0 | $HCO_3$ | 0,0293 | 0,0425 | 0,0317 |
| silt | 15,0 | 31,3 | 20,0 | | | | |
| fine sand | 36,3 | 31,8 | 31,8 | | | | |
| coarse sand | 0,7 | 0,3 | 0,9 | | | | |

It is a heavy soil with brownish lint in the upper horizon, darkening with the depth. The concentration of chlorides in the different horizons varies here considerably with the season due to loss of water in the summer.

In its vegetation it is distinct from all other saline soil varieties. Except for a comparatively narrow shore belt, which is devoid of vegetation, the area is covered densely by the *Arthrocnemum glaucum — Tamarix tetragyna* association. While *Arthrocnemum* constitutes a more or less continuous cover, *Tamarix* is scattered here and there. This association also penetrates deeply

into adjacent wadis of the "Broken Land" inundated by salty water in winter (Plate IV B — p. 96, Vol. II, No. 1).

We wish to mention here a kind of desertic saline found by us in the Far Negeb. In appearance it closely recalls the Takirs of the Middle Asian Countries. It occupies a large depression, into which rainwater arriving from surrounding hills and absorbing high amounts of soluble salts accumulates. In early spring, when the water dries up, the whitish soil possesses a smooth polished surface. Later on it splits into polygonal cracks. No vegetation was found in this soil.

(2) *Ground water solontchaks*

This soil owes its existence to a comparatively high table of salty underground water. The salt content varies with the season, being highest in the dry period. According to its composition it may be divided tentatively into two varieties: (a) gypseous solontchaks, (b) carbonatic solontchaks.

(a) In the former variety belong the salines of the Lower Jordan Valley which occupy considerable tracts mainly of transported soils on both sides of the Jordan and fed by more or less salty and comparatively high underground water. The distribution area of this variety in Palestine extends from the shores of Gulf of Akaba to the Beisan Valley. It harbours the most developed halophytic vegetation.

Topographically this variety is limited to wide wadi bottoms and flats, as well as to outlet regions of the ephemeral wadis of the so-called "Broken Land". There are several well-defined plant associations of the *Suaedion palaestinae*, as well as other associations which characterize this soil. These associations are determined mainly by two edaphical factors, the amount of water available in the soil during the year and the percentage of soluble salts.

The following plant associations may be mentioned here: *Suaedetum palaestinae* and its allied subassociations, the *Suaeda monoica — Suaeda fructicosa* association, *Salsoletum Rosmarini*, *Nitrarietum retusae*, *Suaedetum fruticosae* and the ephemeral association of *Schanginia baccata — Rumex dentatus*.

Another soil variety is characterized by the *Atriplicion Halimi*. Its main association *Atriplicetum Halimi jordanense* occurs in plains, depressions and wadi borders. This soil is not less saline than other solontchaks of this region, but the groundwater table is situated here at a considerable depth and is apparently reached by the extremely long roots of *Atriplex Halimus*.

An examined soil sample of the *Suaedetum palaestinae* at the foot of the "Broken Land" hills near Kalia showed the following composition:

| depth in cm. | 0-10 | 10-20 | 20-30 |
|---|---|---|---|
| water soluble salts | 9,930 | 6,905 | 4,125 |
| Cl | 5,46 | 3,02 | 1,58 |
| $CaCO_3$ | 34,23 | 30,64 | 14,62 |
| pH | 7,9 | 8,2 | 7,8 |

(b) The carbonatic salines occur in the centre of the alluvial and transported soils of the greater valleys (Beisan Valley, Sharon Plain, Zevulun Valley). As an example of the composition of such a soil we may quote some figures obtained by MENCHIKOVSKY (1927) from the Kabbarah marshes, at present almost completely dried out. This soil contained 2,69—7,27% of soluble salts. The amount of these salts increases with the depth. The main constituents of them are chlorides (NaCl, $MgCl_2$). In the Beisan Valley there are considerable spots of salty soils, in which the total amount of soluble salts sometimes reach 4% or more of dry matter.

The vegetation of this soil was studied by us in the Beisan Valley (env. of Massad and Ma'oz). Here saline soils are situated in slight depressions in the midst of an agricultural plain irrigated and rather swampy. The groundwater table is generally very near the surface (1-2 m.). The associations are zonally arranged. The centre of the saline is occupied by *Juncetum maritimi*. The second zone is occupied by the *Statice Limonium — Plantago crassifolia* association; the third and peripheral zone is an *Atriplex Halimus* association, mixed with *Schanginia baccata*.

To this variety we may add secondary salines caused by injudicious irrigation in soils devoid of adequate drainage or by use of irrigation water, in which sodium is a predominant cation. In such cases soils previously free from salt accumulation in the upper layer have been salinized. Such young salines were recently investigated by RAVIKOVITCH (1941) in the Esdraelon Plain. As an extreme example we may mention the heavy soils of Beit-Hashita which according to the aforementioned author become heavily salinized owing to the irrigation method and irrigation water. Spots which prior to the irrigation period contained only 0,1% of salts in the upper layer turned during the period of irrigation to a saline with a salt content of 2,87%—8,14%.

The vegetational aspect of these salines has not yet been studied by the author. What is known is that *Cressa cretica* is one of the first halophytic pioneers, indicating the first stages of salinization in such spots.

(3) *Automorphous solontchaks*

These salines are of more or less primary origin and depend on atmospheric precipitation typical for given climatic territory, without being interfered with by additional hydropedogenic processes. They comprise some dry desert soils in which the salt

content associated with the parent material could not be completely leached out.

As an example we may mention the more or less dry salines of lissan marl region of the Lower Jordan Valley. They are mainly confined to the plains above the "Broken Land" and are well characterized by the *Salsoletum tetrandrae* and a variety of *Salsoletum villosae*.

The soluble salts found in this yellowish-brown soil vary with the depth and the season. In some samples as much as 1% of chlorids were found.

There are scant data on black alkali soils by Menchikovsky (1929) and others. So far as we know these are very limited in surface and do not play an important rôle within the bulk of saline soils of this country. It is however not improbable that further investigation will reveal the existence of greater areas of such soils in the desertic and semi-desertic soils, hitherto uninvestigated or included within the solontchak class.

## Summary and conclusions

(1) A brief and preliminary review of the main soil varieties of Palestine in relation to their vegetation is given here.

(2) Natural vegetation reflects soil conditions only within given climatic and anthropogenic conditions.

(3) Not only primary vegetation units but also secondary communities such as segetal plant associations show close relations to particular soil units.

(4) In Palestine as in other xerothermic regions the nature of the soil is largely determined by the nature of the rock; nearly all the higher soil units mentioned are represented in the Mediterranean as well as in the desert parts of the country.

(5) The subdivision of Palestine into soil regions on the basis of climatical data alone by no means explains pedogeographical facts.

(6) The vegetational differentiation between soil varieties occurring in one and the same phytogeographical territory is determined mostly by the water conditions of these soils or by pedological peculiarities deciding upon water conditions. In desertic and subdesertic region relief, exposure, slope, structure and texture therefore play a much more important rôle in plant life than do chemical properties of the soil.

(7) Man is an outstanding factor responsible for nature and distribution of several soil units in this country. Particularly in the Mediterranean part of the country almost all the soil units are strongly influenced by human interference.

(8) For the study of relations between vegetation and soil in the arid region an ecological approach is needed. The distinction of ecological soil units may lead to a better understanding of some phytogeographical problems and may be of great importance in practical soil research.

## REFERENCES


Ashbel, D. (1930). *Die Niederschlagsverhaeltnisse im suedlichen Libanon, in Palaestina und im noerdlichen Sinai.* Berlin.

— (1938). *Rainfall tables for Palestine and adjacent countries.* Jerusalem.

Avnimelech, M. (1936). Études géologiques dans la région de la Shéphéla en Palestine. Grenoble.

Blake, G. S. (1936). *The stratigraphy of Palestine and its building stones.* Jerusalem.

— (1939). *Geological map of Palestine.* Jaffa.

Blanckenhorn, M. (1918). Der Boden Palaestinas, seine Entstehung, Beschaffenheit, Bearbeitung und Ertragfaehigkeit. *Pro Palaestina, Schrift. Dtsch. Kom. Foerd. Jüd. Pal. Siedlung.* pp. 1-30.

Del Villar, E. H. (1937). *Soils of the Lusitano-Iberian Peninsula (Spain & Portugal).* Los Suelos de la Peninsula Luso-Iberica. Madrid.

Eig, A. (1927). On the vegetation of Palestine. *Agr. Exp. Sta. Tel Aviv.* Bull. 7 : 1-88.

— (1931). Les éléments et les groupes phytogéographiques auxiliaires dans la flore palestinienne. I, II, *Fedde, Rep. spec. nov. Beih.* 63 : 1-201, tab. 120.

— (1933). A historical—phytosociological essay on Palestinian forests of *Quercus Aegilops* L. ssp. *ithaburensis* (Desc.) in past and present. *Beih. Bot. Ctrbl.* Abt. II, 51 : 225-272.

— (1938). On the phytogeographical subdivision of Palestine. *Pal. Journ. Bot.* J Ser. 1 : 4-12.

— (1939). The vegetation of the light soils belt of the Coastal Plain of Palestine. *Pal. Journ. Bot.* J Ser. 1 : 255-308.

Feinbrun, N. and Zohary, M. (1942). *Geobotanical-agricultural investigations in the Southern Shefela of Palestine.* (Mnscr.)

Jones, R. F. (1940). Report of the Percy Sladen expedition to Lake Huleh : A contribution to the study of the fresh waters of Palestine. The plant ecology of the district. *Journ. Ecol.* 28 : 357-376.

Koert, W. (1924). Geologische Beobachtungen in Syrien und Palaestina waehrend des Feldzuges 1917/18. *Ztschr. D. Geol. Ges.*, 76 : 1-46.

Loewengart, St. (1928). Zur Geologie der Kuestenebene Palaestinas. *Ctrbl. Miner. Geol. Palaeont.* Abt. B : 498-519.

Luedi, W. (1939). Beitrag zu den Beziehungen zwischen Boden und Klimaxvegetation in Marokko. Ergebnisse der Internat. Pflanzengeogr. Exkursion durch Marokko u. Westalgerien, 1936. *Veroeff. Geob. Inst. Ruebel,* Zuerich.

Menchikovsky, E. (1927). Some data concerning the salt lands of Palestine. *Agr. Records, Z. O. Inst. Agr. Nat. Hist. Agr. Exp. Sta.* 1 : 49-63.

— (1929). The formation of sodium carbonate in the soils of the Jordan Valley. *Hassadeh* 9 (in Hebrew).

— (1938). The genesis of some loamy soils of Palestine especially regarding their colloidal part. *Soil Research* 6 : 1-20.

— and Adler, S. (1930). Soil relief affecting the changes in composition of red sandy soils. (Contribution to soil study for the rational raising of Citrus trees). *Hadar,* III, 7-8 (in Hebrew).

MONTASIR, A. H. (1938). Egyptian soil structure in relation to plants. *Egypt. Univ. Bull. Fac. Sci.* 15 : 1-47.

NEVROS, K. and ZVORYKIN, I. (1939). Zur Kenntnis der Boeden der Insel Kreta (Griechenland). *Soil Research* 6 : 242-309.

NIKITIN, V. (1926). A study on the soil forming process in the stony desert Ust-Urt (Turkestan). *Perm Bull. Inst. Recherch. Biol.* T. 4, Suppl. 3.

PICARD, L. (1928). Zur Geologie der Kishon-Ebene. *Ztschr. D. Pal. Ver.* 51.
— (1929). Zur Geologie der Beisan-Ebene. *Ztschr. D. Pal. Ver.* 52.
— (1932). Zur Geologie des mittleren Jordantales (zwischen Wadi el-audchsche und Tiberias-See). *Ztschr. D. Pal. Ver.* 55.
— (1938). Synopsis of stratigraphic terms in Palestinian geology. *Bull. Geol. Dept. Hebr. Univ.* II, 2 : 1-24.
— and AVNIMELECH, M. (1937). On the geology of the Central Coastal Plain. *Bull. Geol. Dept. Hebr. Univ.* I, 4 : 1-45.
— and SOLOMONICA, P. (1936). On the geology of the Gaza-Beersheba District. *Bull. Geol. Dept. Hebr. Univ.* I,2 : 1-44.

PUFFELES, M. (1936). A preliminary survey of some soils in the Jordan Valley. *Hadar* IX, 9-10 : 1-23.
— (1937). Some data on the Mediterranean red soils. *Soil Science* 44,2 : 167-174.
— (1939). Effect of saline water on Mediterranean loess soils. *Soil Science* 47,6 : 447-453.

RANGE, P. (1922). Die Kuestenebene Palaestinas. *Ges. Pal. Forsch.* 8 : 1-22.
— (1923). Philistea. *Ztschr. D. Pal. Ver.* 46 : 130-147.
— (1932). Wissenschaftliche Ergebnisse einer geologischen Forschungsreise nach Palaestina im Fruehjahr 1928. *Ztschr. D. Pal. Ver.* 55.

RAVIKOVITCH, S. (1935). The movement of colloidal clay in red sandy soil etc. *Hadar* 8, 12.
— (1941). The mode of irrigation and its effect on salinization of the soil composition and growth of plants. *Agr. Exp. Sta. Rehovot, Bull.* 28. (Hebrew).
— and BIDNER, N. (1938). Soil salinity as a disturbing factor in the growth of clover in the Ain Harod Area. *Yedeoth — Proceed. Agr. Exp. Sta. Rehovot.* 4 : 3-4 (in Hebrew).
— — (1936). The deterioration of grapevins in alkaline soils. *Yedeoth — Proceed. Agr. Exp. Sta. Rehovot.* 3 : 1-2. (in Hebrew).

REIFENBERG, A. (1927). Die Bodenbildung im suedlichen Palaestina in ihrer Beziehung zu den klimatischen Faktoren des Landes. *Chemie d. Erde,* III.
— (1928). Report on an expedition to Southern Palestine. *Publ. Sci. Invest.* Pal. I.
— (1938). *The soils of Palestine.* London.
— and ADLER, S. (1934). Citrus growes and soil conditions. *Hadar* 7.
— and MOSHICKY, S. (1941). Palestine peat in relation to other peats. *Soil Science* 51 : 173-180.

ZOHARY, M. (1940). On the "ghada"-tree of Northern Arabia and the Syrian Desert. *Pal. Journ. Bot.* J Series. 1 : 413-416.
— (1940). Geobotanical analysis of the Syrian Desert. *Pal. Journ. Bot.* J Series. 2 : 46-96.
— (1940). Forests and forest remnants of *Pistacia atlantica* Desv. in Palestine and Syria. *Pal. Journ. Bot.* R Series 3 : 158-161.
— and FEINBRUN, N. (1942). Outlines of the vegetation of the Negeb (Southern Palestine). (Mnscr.).
— and ORSHANSKY (1942). Geobotanical studies in the salt lands of the Dead Sea Region. (Mnscr.).

# ON SOME LOWER FUNGI OF PALESTINE

By T. RAYSS

(With 2 figures in the text)

This paper is a continuation of our studies on the fungus flora of Palestine and deals with seven parasitic fungi of primitive character. Two of them are new species (*Urophlyctis Astomae* and *Urophlyctis Eryngii*); three are recorded on new hosts (*Urophlyctis Alfalfae* on *Medicago rotata*, *Synchytrium aureum* on *Helianthemum salicifolium* and *Physoderma trachoniticum* on *Cornucopiae cucculatum*). One of them — *Urophlyctis pulposa* — is of special phytopathological interest: it was already recorded as causing serious damage to the cultivated beet in Palestine; we found it on the wild beet — a common weed in Palestine, which might serve to keep the fungus alive from year to year and should be eliminated in the neighbourhood of fields where the beet is cultivated.

## *SYNCHYTRIACEAE*

### 1. **Synchytrium aureum** Schroet.-Cohn's Beitr. Biol. 1 : 36 (1870).

(a) On the leaves of *Helianthemum lasiocarpum* Willk. (= *Helianthemum ledifolium* (L.) Mill. var. *lasiocarpum* Boiss.): LJ: Ein Feshkha, 14.II.1940 (leg. I. Amira).

Resting sporangia: 117-150 μ

This fungus was indicated on *Helianthemum ledifolium* at Maroc by Braun-Blanquet and Maire.

(b) On leaves, petioles and base of stems of *Helianthemum salicifolium* (L.) Mill.: S: Innaba, 13.II.1942 (leg. H. Habelska), JD: Wadi Fara, 1.III. 1942 (leg. H. Habelska).

Resting sporangia: 80-115 μ

On these two hosts *Synchytrium aureum* forms small reddish-brown leaf and stem galls, umbilicated on the top, containing the resting sporangia. The host cells round the cavities with resting sporangia and the resting sporangia themselves contain a brownish red pigment which colours the galls.

## *CLADOCHYTRIACEAE*

### 2. **Urophlyctis pulposa** Schroet.-Kryptfl. III. 1 : 197 (1886).

On leaves, petioles and stems of *Beta vulgaris* L. growing wild along irrigation ditches in a field of clover. CS: Mikve-Israel, 4.III.1942 (leg. H. Habelska).

Resting sporangia: 35-50 μ

I. Reichert, in a note "*Urophlyctis* on Beet" (Yedeoth-Proceedings P.Z.E. Agr. Exp. Sta. Ext. Div., Tel-Aviv, II, 3-4, 1930) gives a detailed description and three figures on this fungus, the causal organism of wartgalls on beet, and calls attention to the sporadic outbreak of this disease in Palestine. The sporadic nature of the infection may be explained by the fact that the wart-fungus occurs on a wild-growing host which keeps alive and supplies infective material from season to season.

3. **Urophlyctis Alfalfae** (Lagerh.) Magn.-Ber. dtsch. Bot. Ges. 20 : 291-296 (1902).

At base of stem of *Medicago rotata* Boiss. JM : Beth-Hakerem, 17.IV.1939. New host.

Resting sporangia : 40-50 μ hemispheric, with a convex base. The fungus forms small galls on the stem near the surface of the soil.

4. **Urophlyctis Astomae** Rayss sp. nov. **Fig. 1.**

Cecidiis bulliformibus, in caulibus, petiolis et in foliolis insidentibus, melleis demum fusco-brunneis, ad 0,5 mm. diam., interdum confluentibus, caulem deformantibus ; sporangiis perdurantibus 30-50 in una pustula, hemisphaericis, 40-62 μ diam.; membrana brunneo-castanea, levi, 3,5-5 μ crassa, stratis duobus formata ; contentu oleoso melleo-brunneo.

Habitat in caulibus, petiolis et in foliis vivis *Astomae sessilifolii* DC. in Palaestina : Hierosolymis 6.IV.1937 (leg. D. Zaitschek).

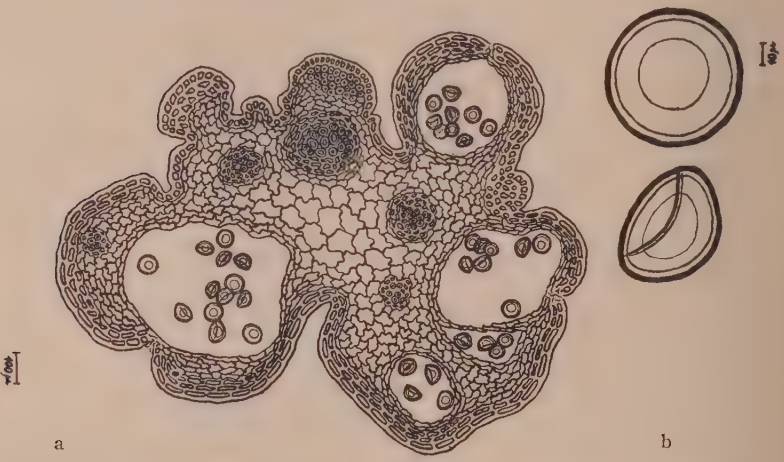



Fig. 1. *Urophlyctis Astomae* Rayss

a. Cross section of a deformated stem of *Astoma sessilifolium* showing cavities with resting sporangia. b. Resting sporangia magnified.

5. **Urophlyctis Eryngii** Rayss, sp. nov. **Fig. 2.**

Pustulis foliicolis vel petiolicolis, circularibus, $^1/_3$-$^1/_2$ mm. diametro, creberrimis, granulatis, initio melleis, dein brunneis; mycelio nullo observato ; sporangiis perdurantibus, 40-60 in una pustula, subglobosis vel hemisphaericis, basi planis, apice convexiusculis, 27-47 μ altis, 42-50 μ latis. Episporio levi, brunneo-castaneo, 3,5-4 μ crasso, stratis duobus formato, externo fusco-brunneo, interno pallidiore. Contentu oleoso melleo-brunneo.

Habitat in foliis vivis *Eryngii cretici* Lam. in Palaestina: SA: Mt. Heteri prope Zikhron-Ya'aqov, 14.III.1940; AP: Kiryat-Amal, 15.III.1940; S: Herzlia, 10.IV.1941.

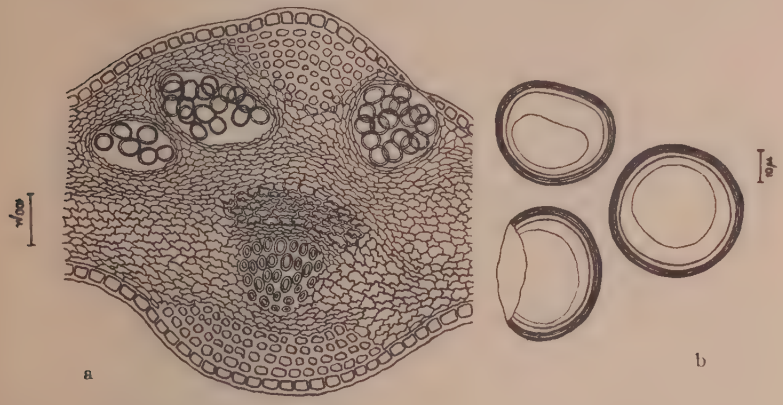



Fig. 2. *Urophlyctis Eryngii* Rayss

a. Cross section in a leaf of *Eryngium creticum* with cavities containing resting sporangia. b. Resting sporangia magnified.

**6. Physoderma trachoniticum** Syd.-Svensk Bot. Tidscr. 29, 1 (1935)

On the leaves of *Cornucopiae cucculatum* L.: AP: Naharia, 16.III.1939.
Resting sporangia: 20-35 x 20-27 μ
This fungus was described by Sydow on *Cornucopiae alopecuróides* from Syria. Our plant is a new host.

*ANCYLISTACEAE*

**7. Lagenidium Rabenhorstii** Zopf-Bot. Ver. Prov. Brandenburg 77 (1878); Nova Acta Acad. Leop. XLVII, 145 (1884).

In cells of *Zygnema* sp., on wet ground. JM: Jerusalem, 7.II.1942.
Coenocytic mycelium 3-4μ diam.; zoosporangia provided with slender exit tubes; kidney-shaped zoospores; oospores: 15-18μ

---

Abbreviations: Districts of Palestine: AP=Acre Plain; CS=Coastal Plain of Shephelah; JD=Judean Desert; JM=Judean Mountains; LJ=Lower Jordan Valley; S=Sharon; SA=Samaria.

# *RHAMNUS PALAESTINA* BOISS. – A NEW HOST OF CROWN RUST

By T. RAYSS and H. HABELSKA

At Allar, on April 21, 1942, during one of our trips to the Judean mountains, we found a shrub of *Rhamnus palaestina* Boiss. heavily infected with a rust-fungus and bearing numerous pycnidia and aecidia on its deformed shoots. With its aecidiospores we inoculated[1] a series of gramineous plants growing in Palestine. Only two of the tested plants have acquired the infection: *Avena barbata* Brot. (after 11 days—uredo-, after 17 days—teleutospores of *Puccinia coronata* Corda) and *Phalaris minor* Retz (after a month — teleutospores of *Puccinia coronata* Corda). *Rhamnus palaestina* is therefore a new host plant for *Puccinia coronata*, but its rôle in the distribution of the crown rust is not important, since *P. coronata* overwinters in our climate in the uredinial stage.

Moreover, *Rhamnus palaestina* is a widely distributed local species of buckthorn characteristic of the maqui-formation and is very rarely attacked by crown rust which is widely found in all parts of Palestine on wild oats and species of *Phalaris*.

This spring we found in the Botanical Garden of the Hebrew University of Jerusalem some shoots of another buckthorn, viz. *Rhamnus Alaternus* L. — infected by a rust, probably *Puccinia coronata* too, but the infection was in the pycnidial stage and we have not yet found aecidia.

[1] For the method of infection see the previous note: H. Habelska, Life-Cycle of the rust on *Anchusa strigosa* Labill. *Pal. Journ. Bot.* J Series, 1: 101-103, 1938.

# ON THE OCCURRENCE OF *DROSERA ROTUNDIFOLIA* L. IN LEBANON

By NAOMI FEINBRUN

The occurrence of *Drosera rotundifolia* in Lebanon is a phytogeographical and ecological enigma. *D. rotundifolia* has been recorded by Post in his Flora (1896); until then the plant was unknown from the region of Boissier's Flora Orientalis. Moreover, this Eurosiberian-Boreoamerican plant scarcely occurs in the Mediterranean region. It is known from northern and central Spain as well as from northern and middle Italy; in France it does not occur in the Mediterranean territory; it has not been recorded from Greece or Asia Minor, and is wholly absent from North Africa. The Lebanon thus seems to be the only East-Mediterranean part of the distribution area of *D. rotundifolia*; here its stations are quite isolated from the main range of the plant. The nearest stations are found in western Bulgaria and southwestern Caucasus (Colchis).

In attempting to explain this disjoined occurrence we must first consider the ecological requirements of *D. rotundifolia*. This plant is generally known as growing on moors where the rain supply is abundant and the soil destitute of $CaCO_3$, poor in nutrient salts and more or less acid. What are the ecological conditions of the habitat of *D. rotundifolia* in Lebanon? Though we have had an opportunity to examine its habitat in the Nubian sandstone area of Dhour Choueir only (S. Lebanon, 1200 m), we have reason to conclude that the ecological and vegetational conditions of the other localities recorded for this plant by Post and others are much the same as in Dhour Choueir, all of the localities being situated on or close to the Nubian sandstone areas, at an altitude of 800-1200 m.

The Nubian sandstone (or Lignitiferous sandstone of Zumoffen, 1926) is referable to the Lower Cretaceous (Neocomian) and is remarkable for lack of chalk and is, at least in its commonest variety, rich in iron. We found *D. rotundifolia*[1] in a *Pinus Pinea*-forest where a small spring on the sandstone slope, produces a small hydrophilic habitat. In the vicinity of the semi-stagnant or slow-flowing water, on wet sandy red soil, sometimes blackened by humus, *D. rotundifolia* grows accompanied by different hydrophilous plants. Close to the water, on more or less

[1] The plant was found by my colleague, Dr. T. Rayss, during our excursion in September 1942. I am grateful to her for calling my attention to this plant. I am also grateful to Mr. E. Konis for analysing samples of soil from this habitat.

wet soil, there grows a small thicket of *Rhododendron ponticum* var. *brachycarpum*, and two ferns species: *Osmunda regalis* and *Blechnum Spicant*.

The soil is destitute of $CaCO_3$ and recalls in this regard the soils of the European heath. But in contrary to that soil it is only slightly acid or neutral (pH 6,4—6,9).

The edaphical conditions of the habitat are accompanied by peculiar climate. As can be seen from the rainfall map of the Near East (ASHBEL, 1940), this part of Lebanon has the highest amount of precipitation (1500—1700 mm.) as compared with all of Syria and Asia Minor. During the dry season the transpiration rate is presumably lowered by lack of strong winds; winds are generally mild on the western slopes of the Lebanon, which are protected from the East by a wall of the Lebanon's highest summits and ranges. This fact must be of great importance for the mesophytic vegetation, especially during the period of the eastern "Hamsin" winds.

The geographical isolation and the peculiar ecological conditions in which *D. rotundifolia* grows in the Lebanon give rise to the assumption of the relic character of these habitats. The expansion of *D. rotundifolia* to the South probably took place during a period when the climate was cooler and damper in this part of the Mediterranean. According to GARROD and BATE (1937) a cool wet climate dominated Palestine during the Upper Levalloiso-Mousterian, which is synchronized by ZEUNER (1940) with the Wuerm I. It is not improbable that during this period *D. rotundifolia* had the possibility of advancing South at least as far as S. Lebanon. There this northern species can maintain itself because of the favourable climatic conditions, while the edaphic conditions of the Nubian sandstone are rather unfavourable to Mediterranean vegetation, and competition is thus rather weak.

## REFERENCES

ASHBEL, D. (1941). *Rainfall Map. Near East.* Jerusalem.

GARROD, D.A.E. and BATE, D.M.A. (1937). *The Stone Age of Mount Carmel. Excavations at the Wady el-Mughara.* Oxford.

POST, G.E. (1896). *Flora of Syria, Palestine, and Sinai.* Beirut.

ZEUNER, F.E. (1940). *The Age of Neanderthal Man, etc.* Geochronological table No. 2. Univ. Lnd. Inst. Archaeol.

ZUMOFFEN, G.S.J. (1926). *Géologie du Liban.* Paris.

# על מציאותה של Drosera rotundifolia L. בלבנון

מאת נעמי פינברון

מציאותה של Drosera rotundifolia בלבנון מענינת מבחינה פיטוגיאוגרפית ואקולוגית. זהו צמח של האזור האירוסיבירי–בוריאואמריקאי החודר רק במקצת לתוך האזור הים תיכוני. מקומות המצאו הקרובים ביותר ללבנון הם בולגריה המערבית וקוקז הדרומית־מערבית, בו בזמן שמאסיה הקטנה אין הוא ידוע. בית גדולו של הצמח בלבנון הוא קרקע חול לח בקרבת מעינות אשר בשטחי האבן החול הנובית, בגובה של 800–1200 מ'; שטחים אלה מיוערים עפי"ר ב-Pinus Pinea. בית גדול זה דומה במדה ידועה לבית גדולו של D. rotundifolia באירופה. כמות המשקעים בחלקים אלה של הלבנון גבוהה (עד 1500 מ"מ) והקרקע מחוסר $CaCO_3$; לעומת זאת הקרקע חמוץ רק במדה חלשה או אפילו סתמי (pH 6,4–6,9). יש להניח שצמח זה חדר דרומה עד ללבנון בתקופת Levalloiso-Mousterian (החלה בחלק העליון של תקופת הקרחונים) שבה שרר, לפי חקירות פריהיסטוריות, בחלק זה של הים התיכון אקלים לח וקריר יותר מזה של ימינו.

4. קרקעות הלֶס נפוצים מאד בנגב ובעבר הירדן המזרחי. בין השאר הבחנו בין הלס הטפוסי והלס הפלוביטילי. הראשון מאופין ע"י שורה של חברות צמחים סגטליות הנמנות על האגד Achilleion Santolinae והשני ע"י Haloxylonetum articulati. Artemisietum Herbae albae היא חברת הקלימקס של הקרקעות האלה.

5. בשם קרקעות אלוביאליים הכללנו את קרקעות הבצה, קרקעות הגדות של מרוצי המים, קרקעות מוצפים, קרקעות אואזיסים וקרקעות שלחין. גם כאן מקבילה לשורה של יחידות קרקעיות שורה של חברות צמחים (ראה בגוף המאמר).

6. מקום מיוחד תופסים בארץ קרקעות המלחה. הללו מופיעים גם בחבל הים תיכוני וגם בחבלים הארידיים של הארץ. עמק הירדן התחתון הוא המקום הקלסי ללמוד הורינטים השונים של הקרקע הזה ושל חברות הצמחים הקשורות להם. החידרטורה של הקרקע, כמות המלחים (בעיקר כלורידים), עמק מי התהום, ארך זמן ההצפה הן נקודות בסיס חשובות לקלסיפיקציה של המלחות. מתוך חברות הצמחים נזכיר את חברת Arthrocnemum glaucum — Tamarix tetragyna (מלחות מוצפות במשך זמן ארוך), Suaedetum palaestinae (מלחות מי תהום קרובים), Salsoletum tetrandrae (מלחות יבשות של חָוֵר הלשון) וכו'.

## על מספר פטריות נמוכות מארץ־ישראל

מאת ט. ר י י ס

עבודה זאת היא תוספת חדשה להכרת הפטריות של א"י. נתונה בה רשימה של 7 פטריות טפיליות נמוכות. שתים מהן — מינים חדשים למדע, שלוש — טפילים על פונדקאים חדשים ואחת — חשובה מבחינה פיתופתולוגית, באשר היא גורמת למחלת יַבֶּלֶת הסלק. היא ידועה על סלק המספוא והסוכר (רייכרט): מצאנוה על הסלק הבר, עשב רע בשדות. פונדקאי זה יכול להעביר את המחלה משנה לשנה, כך שיש לא רק להזהר מלזרוע סלק תרבותי במקומות שבהם הופיעה המחלה, אלא גם להשמיד את הסלק הבר ממקומות האלה.

## כפנדקאי חדש של חלדון Rhamnus palaestina Boiss.
## Puccinia coronata

מאת ט. ר י י ס וח. ח ב ל ס ק ה

הוכח על ידי נסיונות הדבקה שנבגי הכוסית (aecidiosporae) של החלדון, הנמצאים על Rhamnus palaestina מפתחים נבגי בכורה (uredosporae) ונבגים אפילים (teleutosporae) על Avena barbata ו־Phalaris minor. שתי הפטריות הנ"ל נכללות בתוך מחזור החיים של Puccinia coronata Corda.

הפיסיקו־כימיות של סלע־האם. בתנאים אקלימיים שונים יכולים, איפוא, להוצר סוגי קרקע שונים בהתאם להרכב הפטרוגרפי של הסלע. כך למשל, אנו מוצאים בחבל האקלים הים תיכוני קרקע terra rossa, בצדם של קרקע בזלת, קרקע חול וכו׳.

ששת הסוגים העיקריים של קרקעות א״י הם: קרקעות גירניים, קרקעות בזלתיים, קרקעות חול, קרקעות לָס, קרקעות אלוביאליים, וקרקעות מלוחים.

1. הקרקעות הגירניים תופסים את השטחים הגדולים ביותר בכל שלושת החבלים הפיטוגיאוגרפיים של א״י. הם מופיעים בורינטים אקולוגיים רבים שכל אחד מתאפין ע״י צומח משלו. הקרקע האדום (terra rossa) הוא הורינט החשוב ביותר. מבחינה אקולוגית וצמחית יש להבחין בו שתי יחידות: terra rossa הררית הנוצרת in situ ו־terra rossa של העמקים הנגרפת מההרים. שניהם נבדלים בחברות הקלימקס ובחברות המשניות. בין חברות הקלימקס נזכיר כאן את חברת Quercus calliprinos — Pistacia palaestina וחברת Ceratonia Siliqua — Pistacia Lentiscus. בין החברות המשניות הסגטליות — את חברת Prosopis farcata — Sco-lymus maculatus ואת חברת Ononis leiosperma — Carthamus tenuis.

סוג קרקע נפוץ למדי גם בא״י המערבית וגם בעבר הירדן המזרחי הוא הקרקע הגירני הלבן. בחבל הים תיכוני הקלימקס של קרקע זה הם יערות של Pinus halepensis ו־Quercus ithaburensis. החברות הדגרדציוניות של הקרקע הזה מצטינות בנוכחות של מספר קומפוננטים הנמנים על האלמנט האירני־טורני.

הקרקעות הגירניות האפורות הערבתיות מתאפינות ע״י צומח מיוחד משלהם (Herbae albae, Artemisietum, Noeetum mucronatae, Salsoletum villosae וכו׳). לקרקעות הגבס אפיניים Chenoleetum arabicae ו־Suaedetum asphalticae; לקרקעות החמדה Anabasidetum articulatae וכו׳.

2. בקרקעות הבזלתיים יש גם כן להבחין בין קרקע ההרים וקרקע העמקים. לפחות ביחס לחברות הסגטליות והדגרדציוניות שונים שני הורינטים זה מזה (ראה בגוף המאמר).

3. קרקעות החול מופיעים בארץ בורינטים רבים. מהם הקשורים לחבל הים תיכוני ומהם המיוחדים למדבריות של הארץ. בחוף הים אפינית לחולות הנעים, בין השאר, חברת Ammophila arenaria — Cyperus conglomeratus, בשעה שלחולות היציבים למחצה אפינית חברת Artemisia monosperma — Cyperus mucronatus. חברת Lithospermum callosum—Scrophularia hypericifolia מצינת את שדות החול וחברת Eragrostis bipinnata — Centaurea procurrens קשורה לקרקע חול חמרה. לגבעות הקורקר אפיניות החברות Helianthemetum ellipticae וחברת Poterium spinosum — Thymelaea hirsuta.

לחולות הנעים של המדבריות קשורה החברה Aristidetum scopariae. לקרקעות החול של אבן החול הנובית וכן גם לקרקעות החול המתהוים מתוך סלעי הגרניט אפינית שורה של חברות צמחים מיוחדות שמהם נזכיר את Anabasis articulata — Zilla spinosa, Retama Roetam — Calligonum comosum ו־Haloxylonetum persici

# עתון לבוטניקה

כרך ב׳ חוב׳ ד׳ סדרת ירושלים כסלו תש״ג

## מחקר בקרתי על מיני Onopordon של ארץ־ישראל, סוריה והארצות הסמוכות

מאת א. איג[1]

במחקר זה נתן ברור מיני Onopordon של ארץ־ישראל, סוריה והארצות הסמוכות, המהוות יחד את מקום הרכוז העיקרי של מיני הסוג הזה. תוארו כאן 10 מינים, 2 בנות־מין ו־4 וריאטים חדשים למדע. הרשימה של מיני Onopordon של ארץ־ישראל כוללת את: O. cynarocephalum, O. carduiforme, O. telavivense, O. alexandrinum, O. palaestinum, O. anisacanthum, O. transjordanicum, O. macrocephalum, O. horridissimum, O. jordanicolum.

הסמנים החשובים ביותר להבחנת המינים של Onopordon הם הגודל והמבנה של הציצית. אורך הציצית ואורך השערות הצדדיות של זיפי הציצית גדלים והולכים במדה שמתקדמים אל החבלים החרבים. המינים הים־תיכוניים הם איפוא בעלי הציצית הקצרה ביותר וזיפיה מחוספסים בלבד; מינים אלה הם בעלי קרקפות קטנות שקשקשיהן קצרים. לעומת זאת המינים האירנו־טורניים והאירנו־טורניים — סהרו־סינדיים מצטיינים בציצית ארוכה שזיפיה מנוצים; קרקפותיהם גדולות ובעלות קשקשי מעטפת ארוכים וחזקים.

## האספקט הצמחי של קרקעות ארץ ישראל

מאת מ. זהרי

במאמר זה נעשה הנסיון לאפין את קרקעות הארץ ע״י נתונים גיאובוטניים. הגישה האֶדפית ללמוד יחידות הצומח והגישה הגיאובוטנית להגדרתן של יחידות קרקעיות יכולה, לפי דעתנו, להיות יעילה מאד בחקירת הקרקעות והצומח גם יחד.

רב הקרקעות של א״י אינם בוגרים כל צרכם הודות לפרוצסי הסחיפה הפועלים כאן באפן מתמיד. גם גורמים אנטרופוגניים ואקלימיים מביאים להתחדשות מתמדת של אפקי הקרקע העליונים. בחלקים האריידים של הארץ במקום שהרוח פועלת בכוון של דֶפלציה והשקעה של חמרי הקרקע ובמקום שפרוצסי ההתרוחות הכימית פועלים רק במדה מצומצמת אין הקרקע יכול להגיע לסטדיום של בגרות אלא במקרים מיוחדים. מהותם של טפוסי הקרקע העיקריים בא״י אינה נקבעת ע״י הגורמים האקלימיים בלבד כ״א גם, ובמקרים רבים בעיקר, ע״י התכונות

[1] מתוך העזבון המדעי.

# עתון לבוטניקה

סדרת ירושלים

# עתון לבוטניקה

## מופיע בשתי סדרות

**א. סדרת ירושלים:**

יוצאת לאור ע"י חבר העובדים של המחלקה לבוטניקה באוניברסיטה העברית ירושלים. בכל שנה מופיעות 4 חוברות וכל חוברת נושאת עליה את תאריך הופעתה. כל כרך שנתי מכיל מ-300 עד 400 עמודים.

**ב. סדרת רחבות:**

יוצאת לאור ע"י ה. ר. אופנהיימר וי. ריכרט של התחנה לחקר החקלאות, רחבות, א"י בכל שנה מופיעות 2 חוברות וכל חוברת נושאת עליה את תאריך הופעתה. כל כרך שנתי מכיל מ-200 עד 250 עמודים.

•

במכתבים הנוגעים לעניני המערכת של סדרת ירושלים יש לפנות לד. ו. זיצ'ק. ת. ד. 620, ירושלים — ולעניני המערכת של סדרת רחבות לעורכי "עתון לבוטניקה", ת. ד. 15, רחבות.

•

את דמי החתימה יש לשלם למסרע ע"י שק או המחאת דואר לפי הכתובת: ההנהלה של העתון לבוטניקה, ת. ד. 620, ירושלים. מחיר החתימה הוא:

1.250 לא"י לשנה, בעד שתי הסדרות
0.900 לא"י לשנה, בעד סדרת ירושלים בלבד
0.600 לא"י לשנה, בעד סדרת רחבות בלבד

בסכום זה נכללים גם דמי המשלוח.

(מחיר חוברת בודדת 0.300 לא"י ושל כפולה 0.600 לא"י).

•

במכתבים עסקיים, בכלל זה הודעה על שנוי בכתובת, מודעות וכו' יש לפנות להנהלת העתון לבוטניקה, ת. ד. 620, ירושלים.

---

דפוס עזריאל, ירושלים.

סדרת ירושלים כרך ב׳ חוב׳ ד׳ כסלו תש״ג

# עתון לבוטניקה

## סדרת ירושלים

יוצא לאור על ידי
חבר העובדים של המחלקה לבוטניקה באוניברסיטה העברית

## תכן



ירושלים